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(54) **METHOD AND APPARATUS FOR DISPLAYING CHARACTERS AND/OR IMAGES**

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(73) Assignee: **Prochips Technology Inc.** (KR)

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(58) **Field of Search** 315/169.1, 169.2, 315/169.3, 224

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(74) *Attorney, Agent, or Firm*—Webb Ziesenheim Logdson Orkin & Hanson, P.C.

(57) **ABSTRACT**

The method of the present invention includes the first step of applying power to a character and/or image display apparatus and setting up input/output port values and initialization values, the second step of initializing all LED values and clearing a screen, the third step of reading initial picture data from a nonvolatile backup memory, the fourth step of writing the data read from the backup memory into a working memory, the fifth step of reading initialization data from the working memory, the sixth step of displaying an initial picture and performing a still mode until a rotation speed of a motor becomes stable, the seventh step of reading data other than the initialization data from the working memory, the eighth step of sequentially performing modes corresponding to commands contained in the read data, and the ninth step of repeating the above seventh and eighth steps until all commands stored in the working memory are processed.

20 Claims, 18 Drawing Sheets

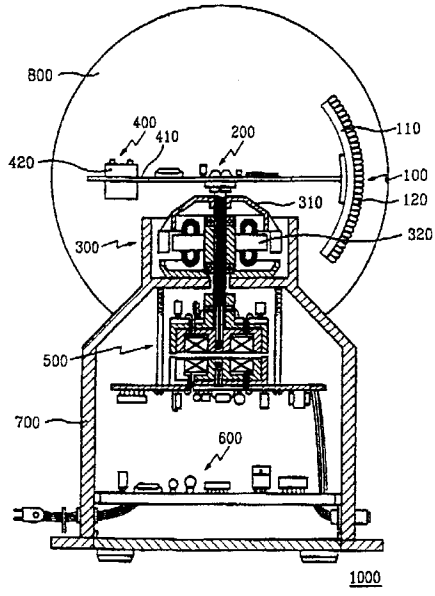


Fig. 1

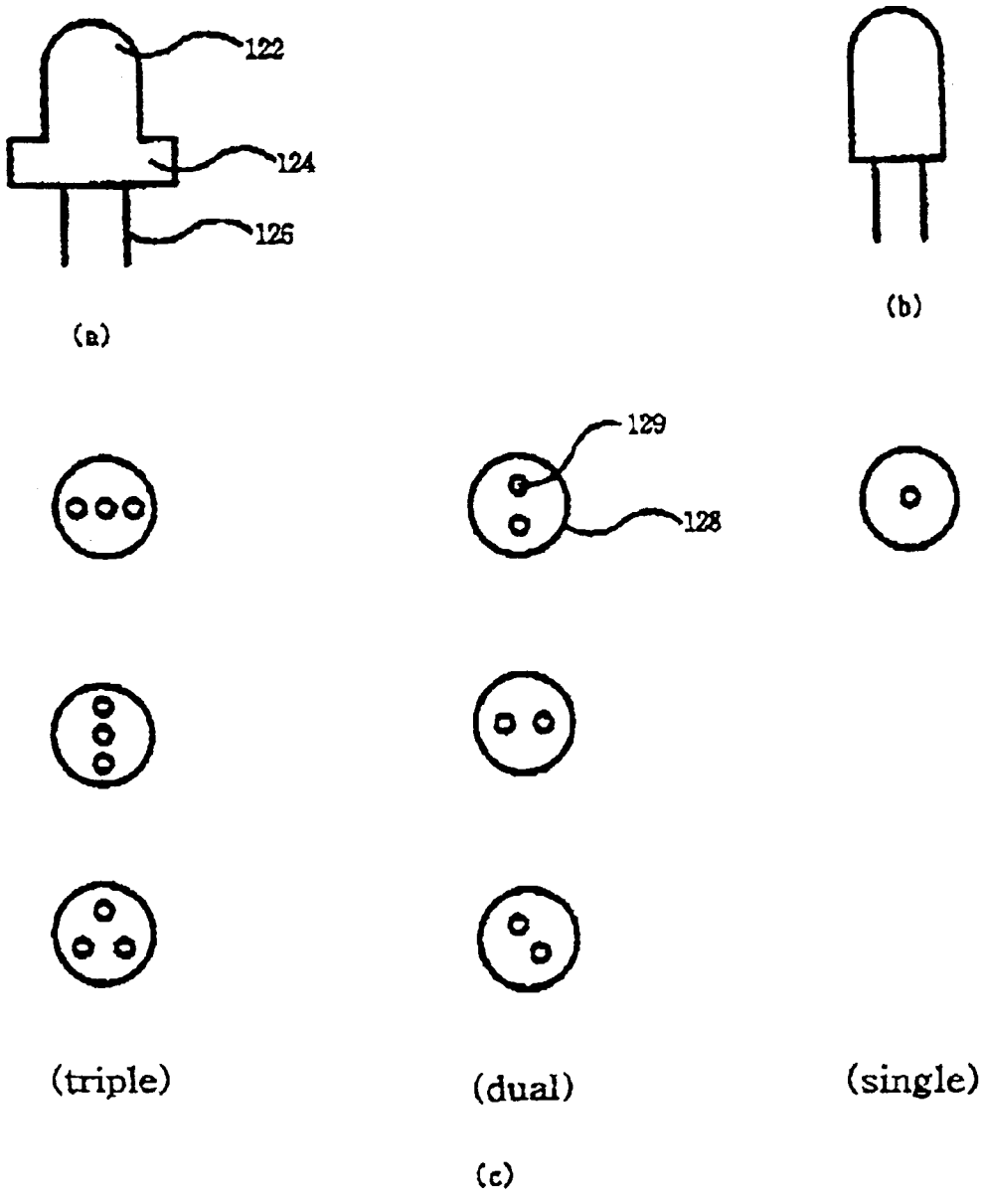


Fig. 2

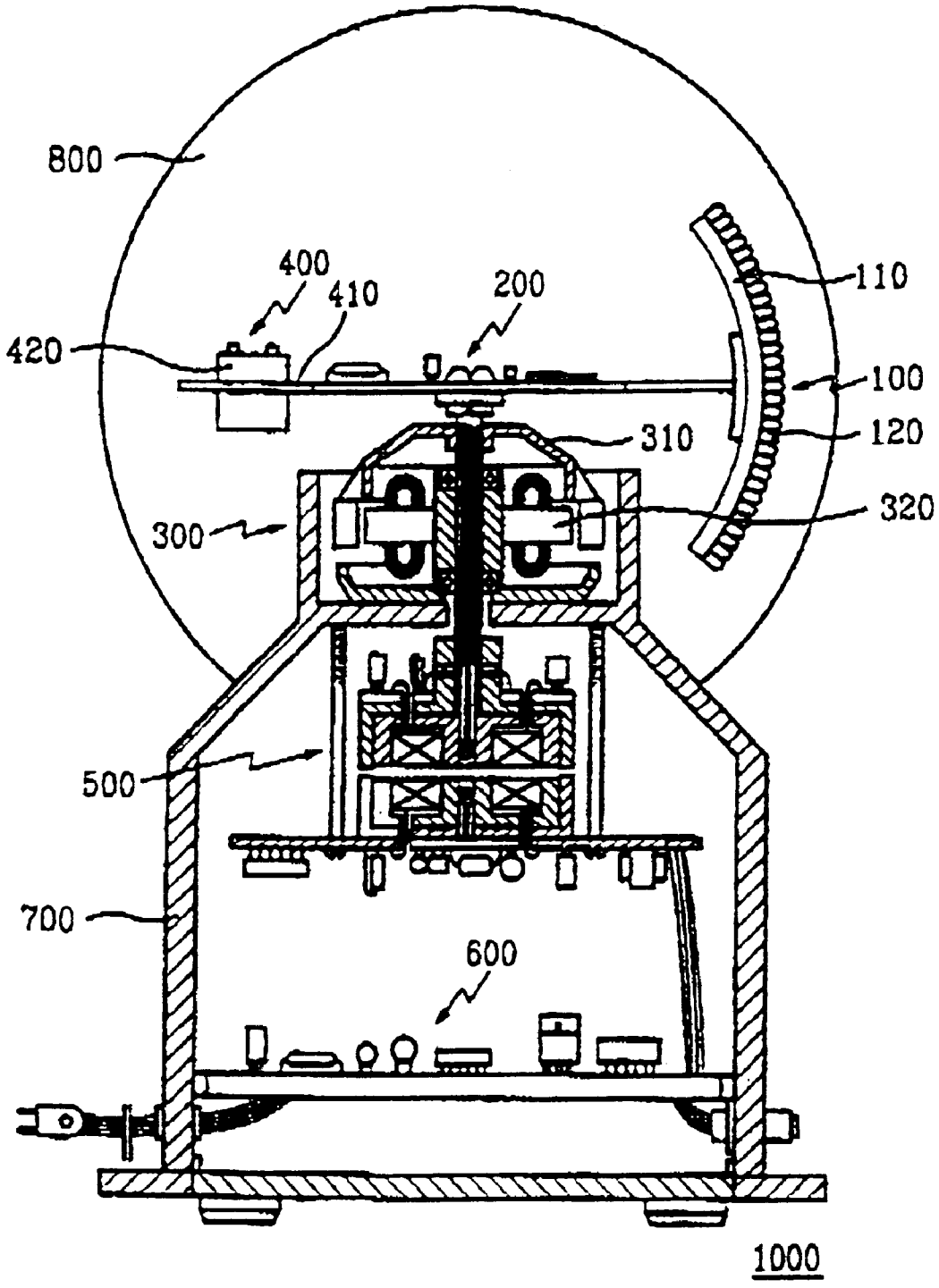


Fig. 3

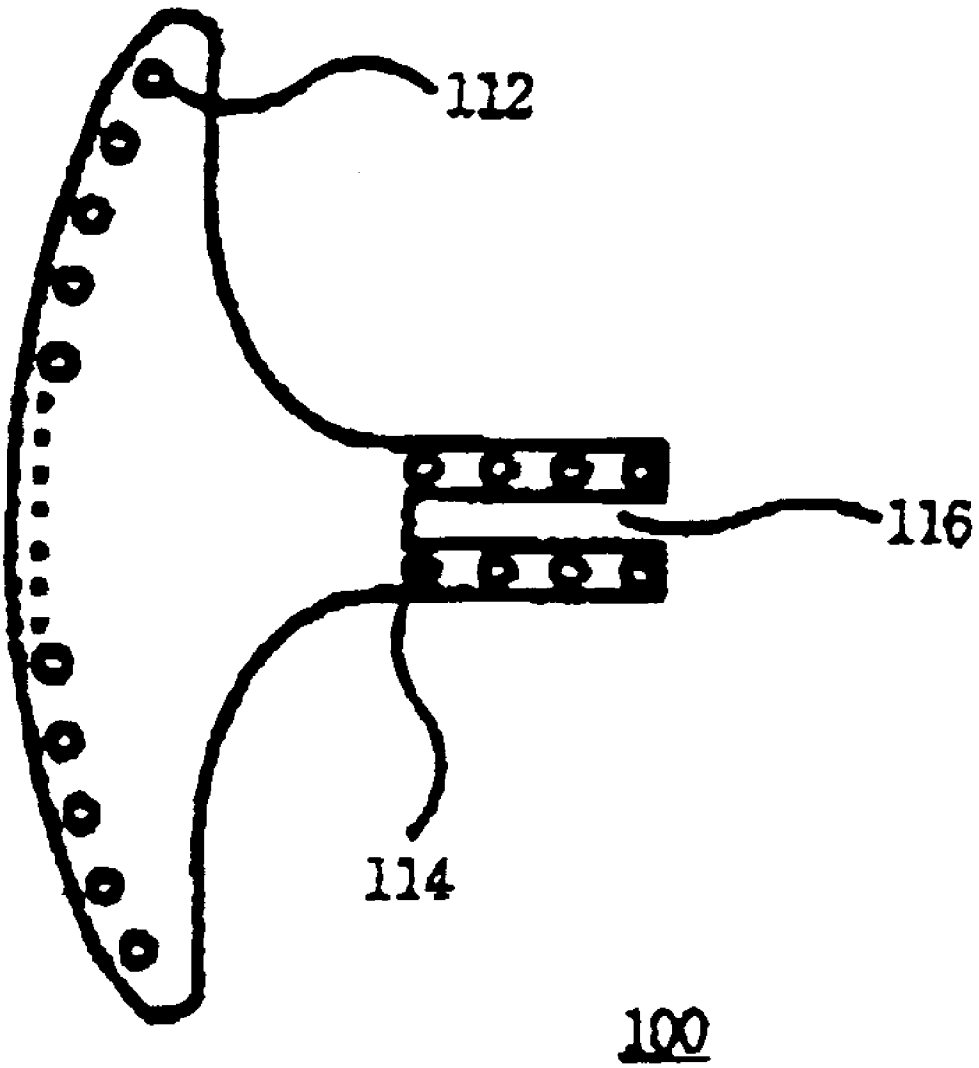


Fig. 4

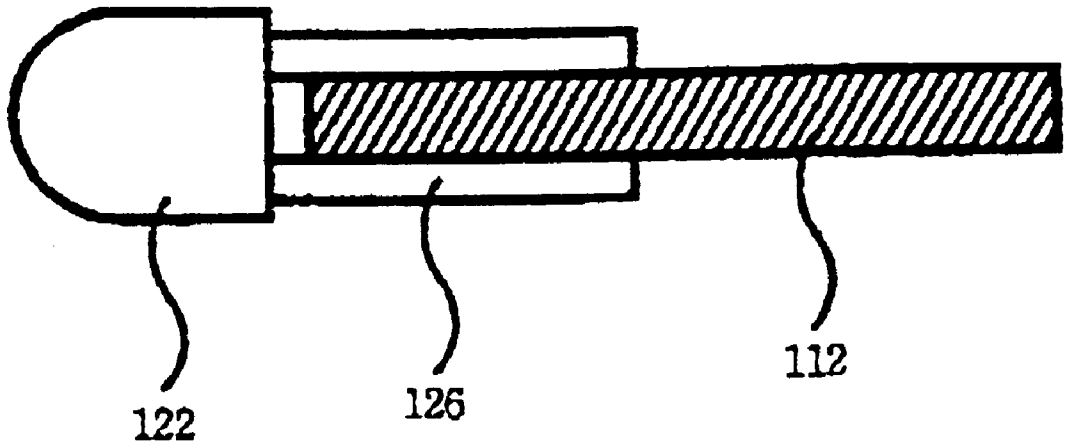
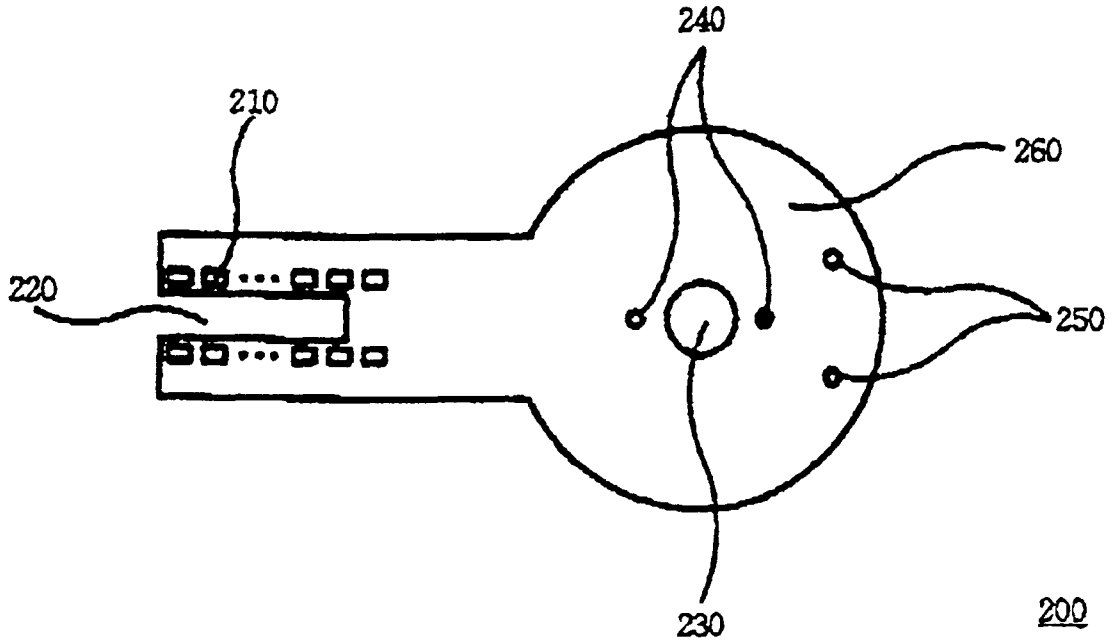


Fig. 5



(a)

(b)

Fig. 6

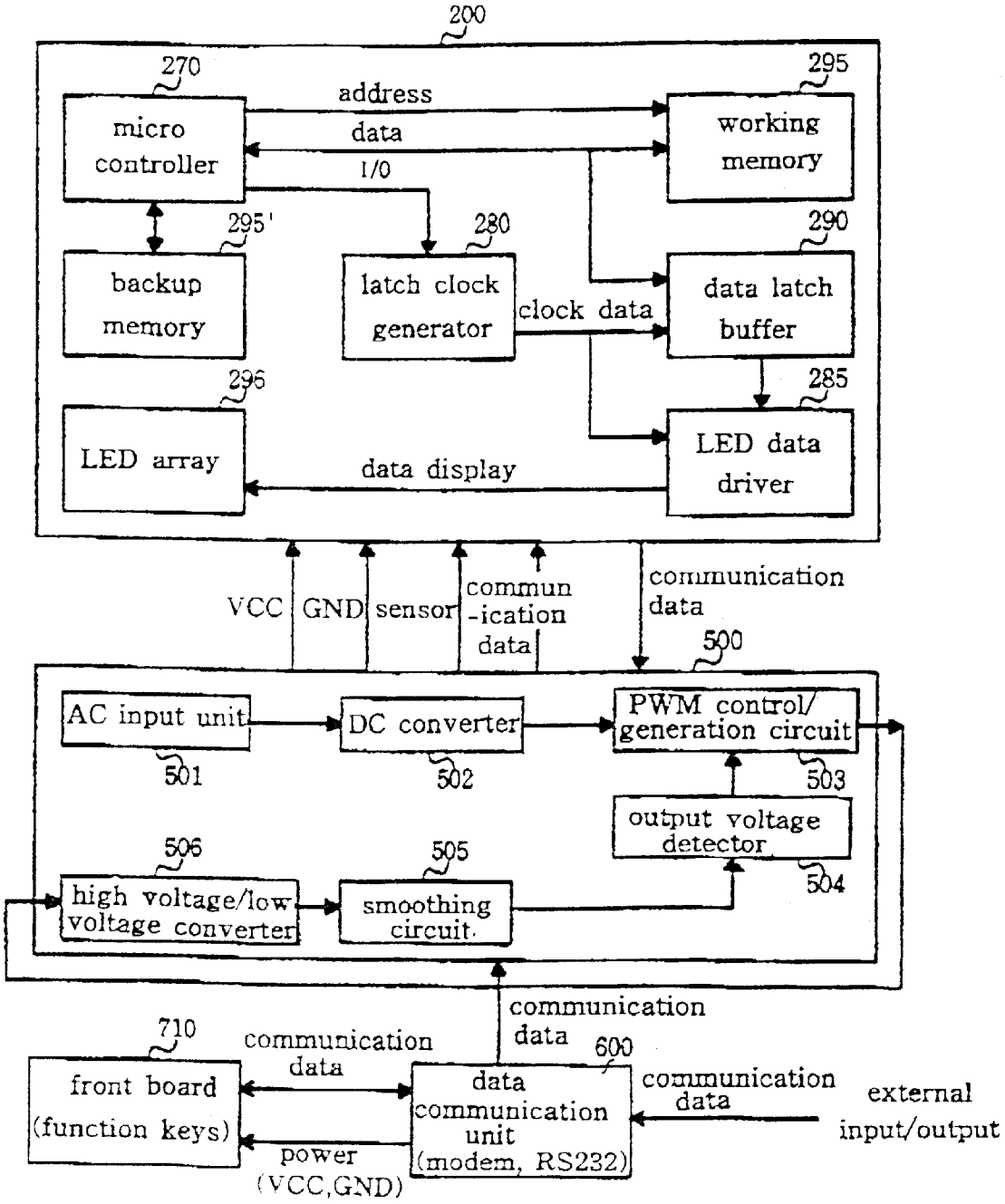

200
270
micro controller
address
data
I/O
295
working memory
295'
backup memory
280
latch clock generator
clock data
290
data latch buffer
296
LED array
data display
285
LED data driver
VCC
GND
sensor
commun -ication data
communication data
500
AC input unit
501
DC converter
502
PWM control/ generation circuit
503
output voltage detector
504
505
smoothing circuit
506
high voltage/low voltage converter
communication data
710
front board (function keys)
communication data
power (VCC,GND)
600
data communication unit (modem, RS232)
communication data
external input/output

Fig. 7

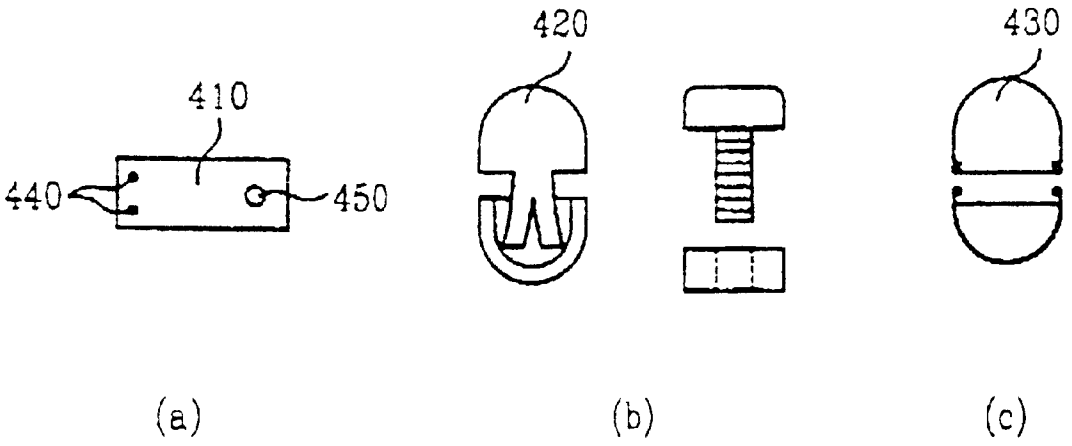


Fig. 8

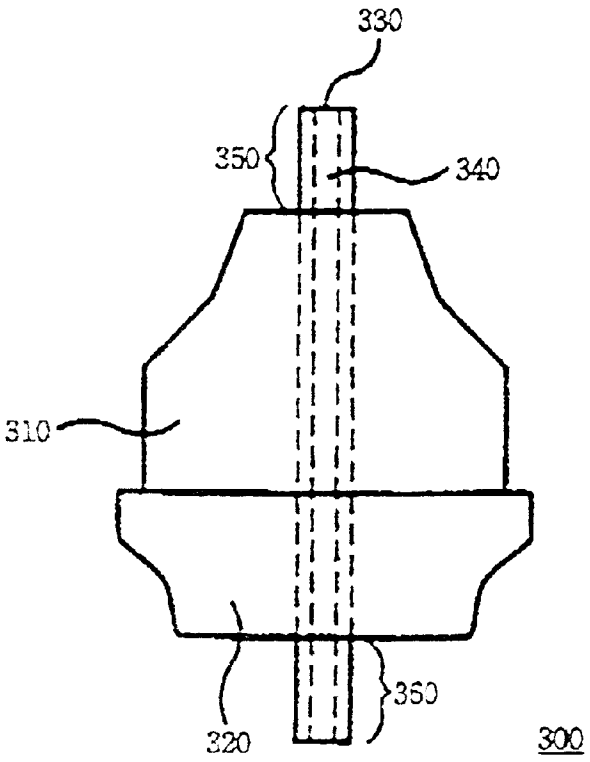
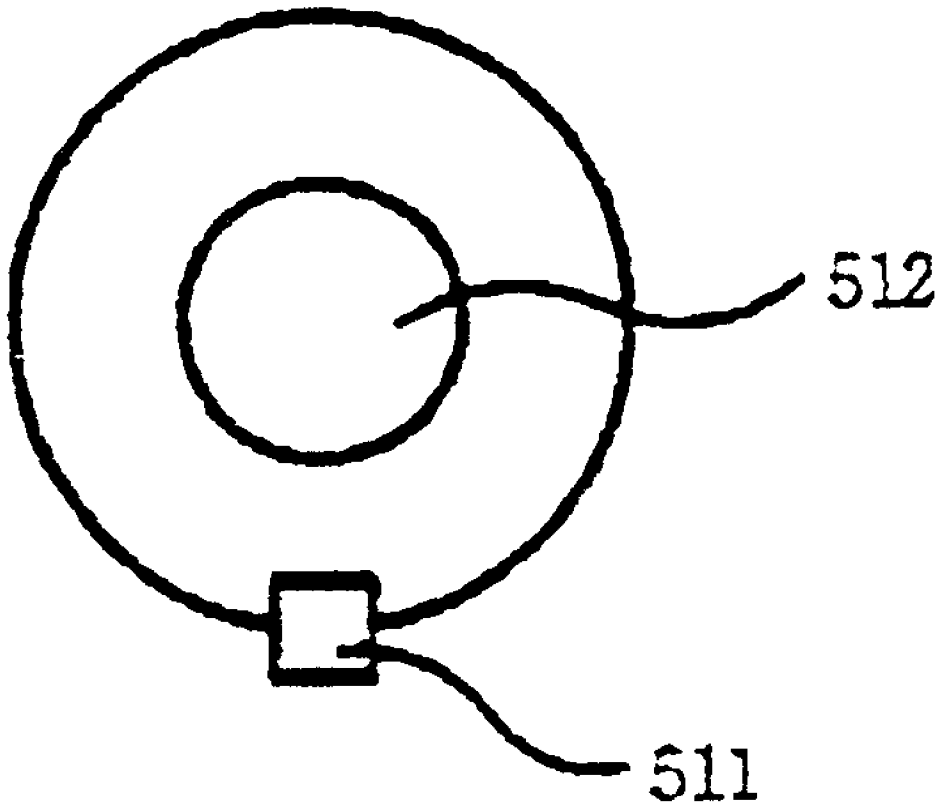


Fig. 9



510

Fig. 10

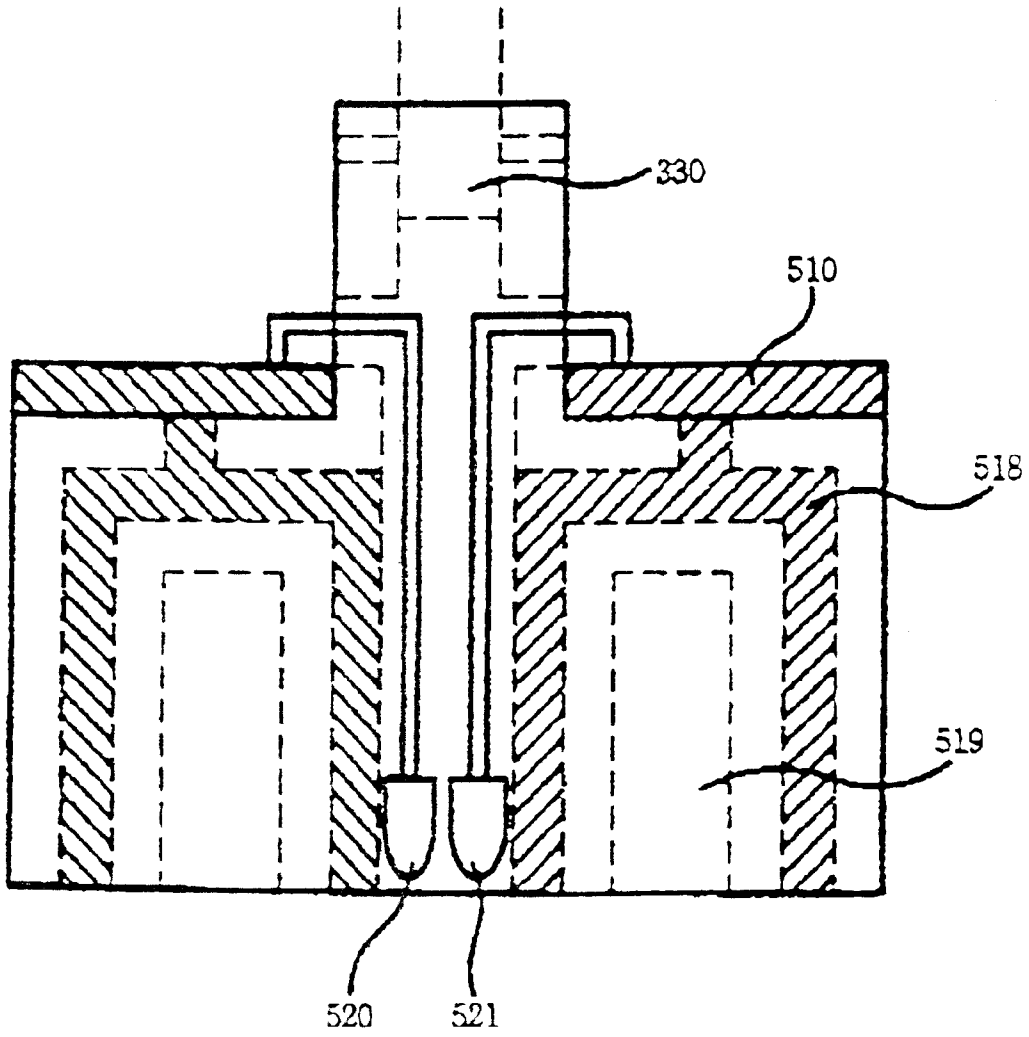


Fig. 11

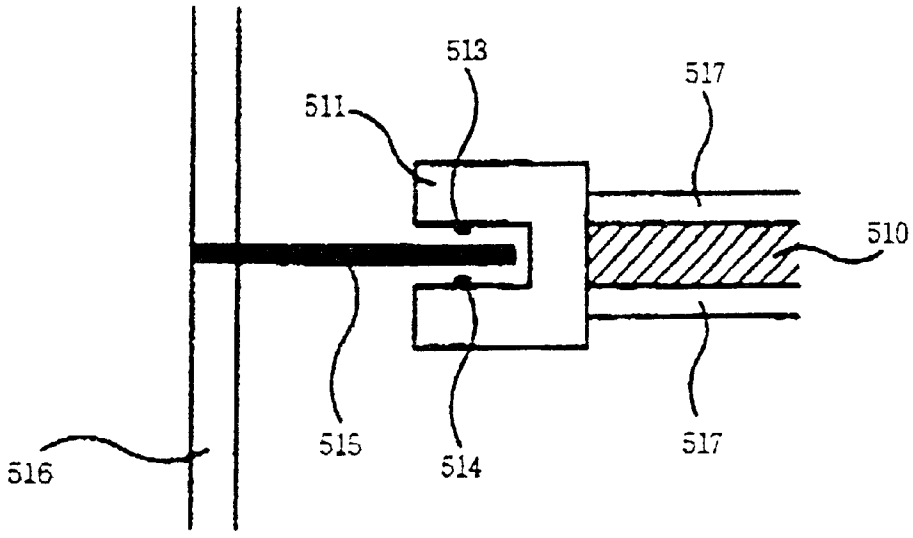


Fig. 12

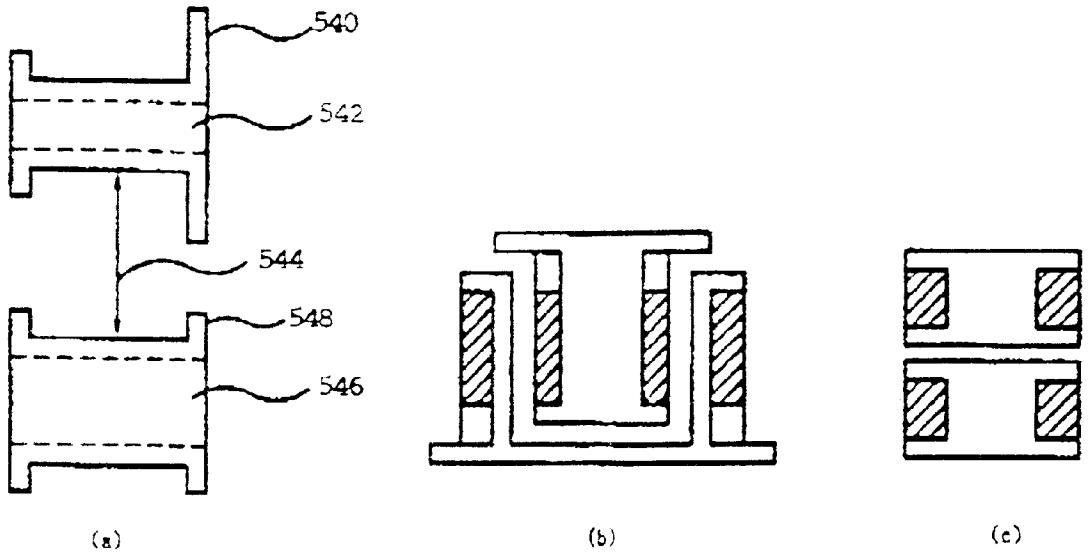


Fig. 13

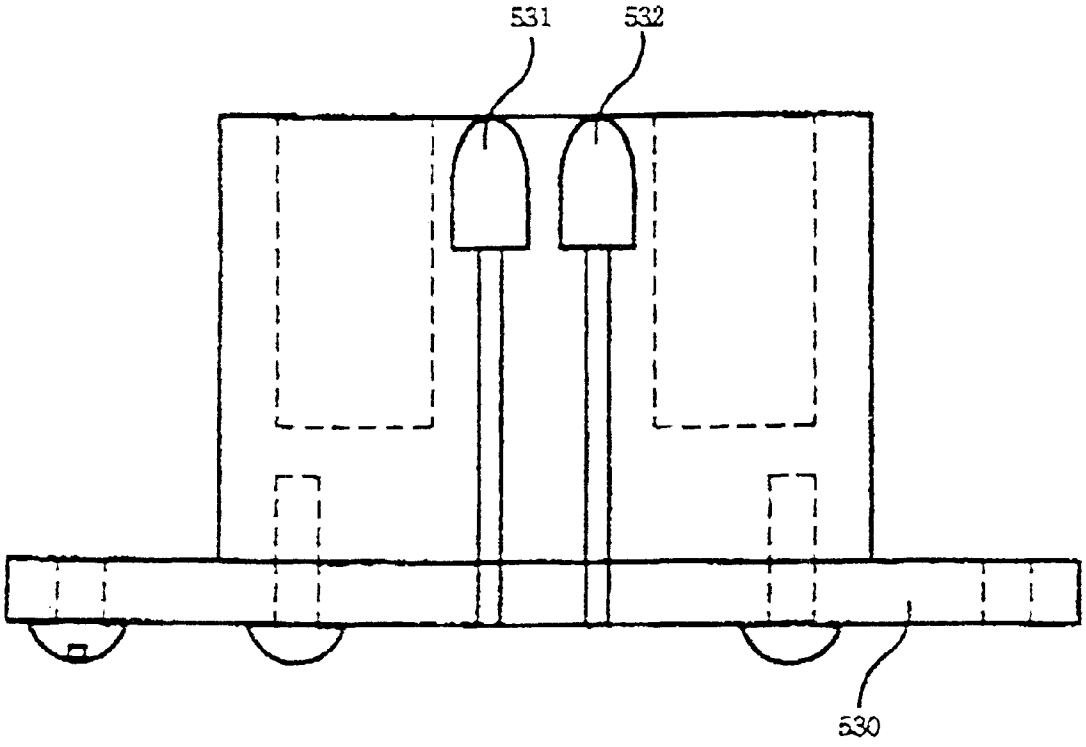


Fig. 14

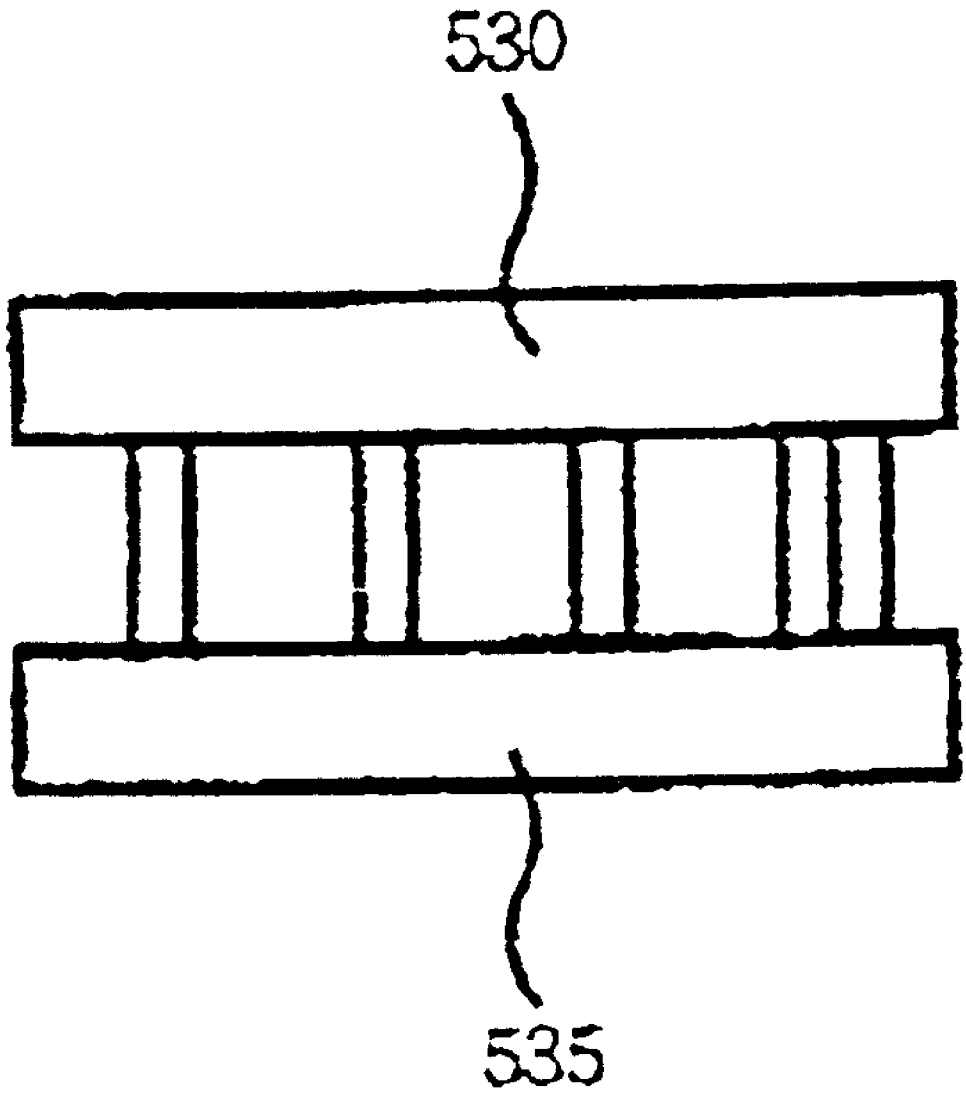


Fig. 15

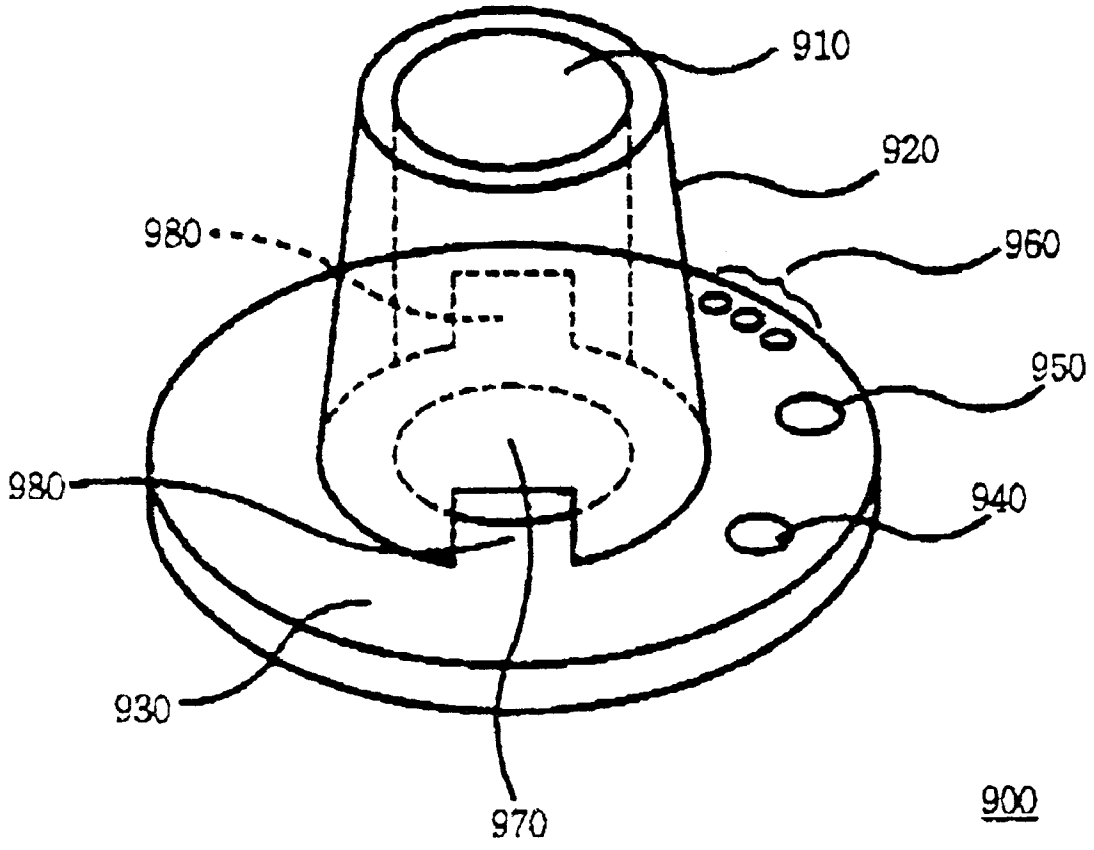


Fig. 16

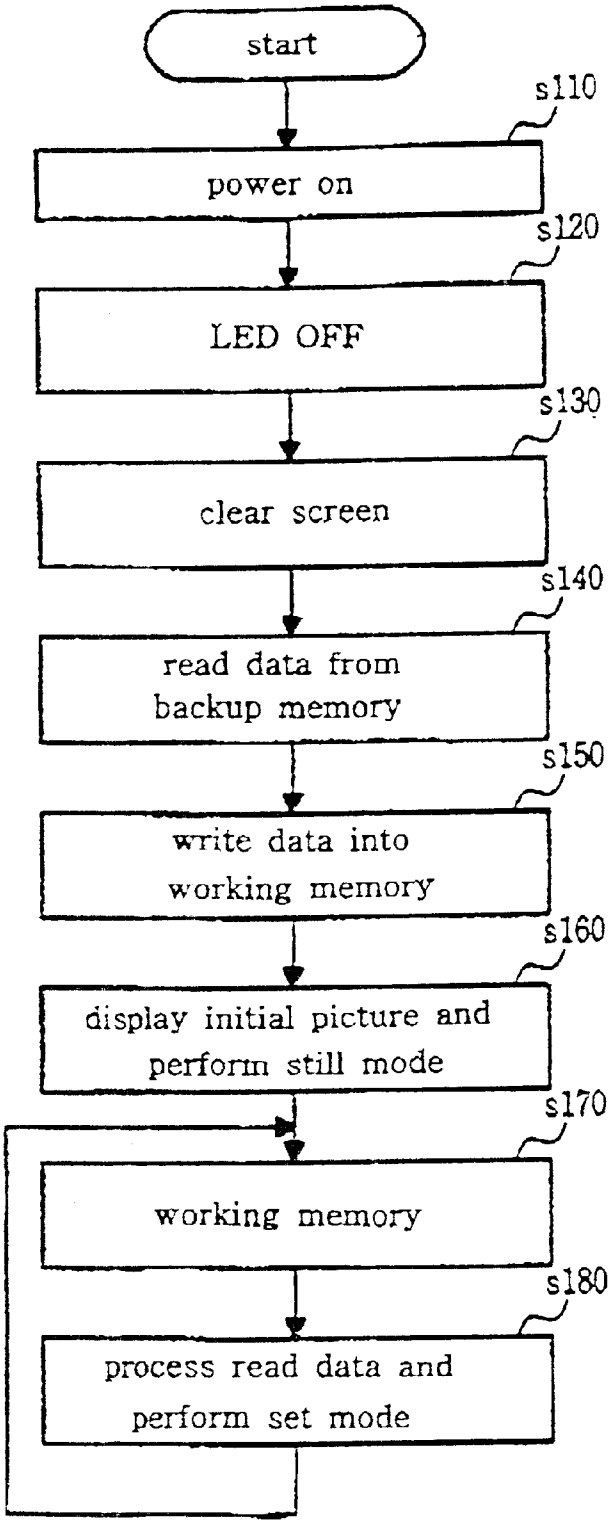

start
s110
power on
s120
LED OFF
s130
clear screen
s140
read data from backup memory
s150
write data into working memory
s160
display initial picture and perform still mode
s170
working memory
s180
process read data and perform set mode

Fig. 17a

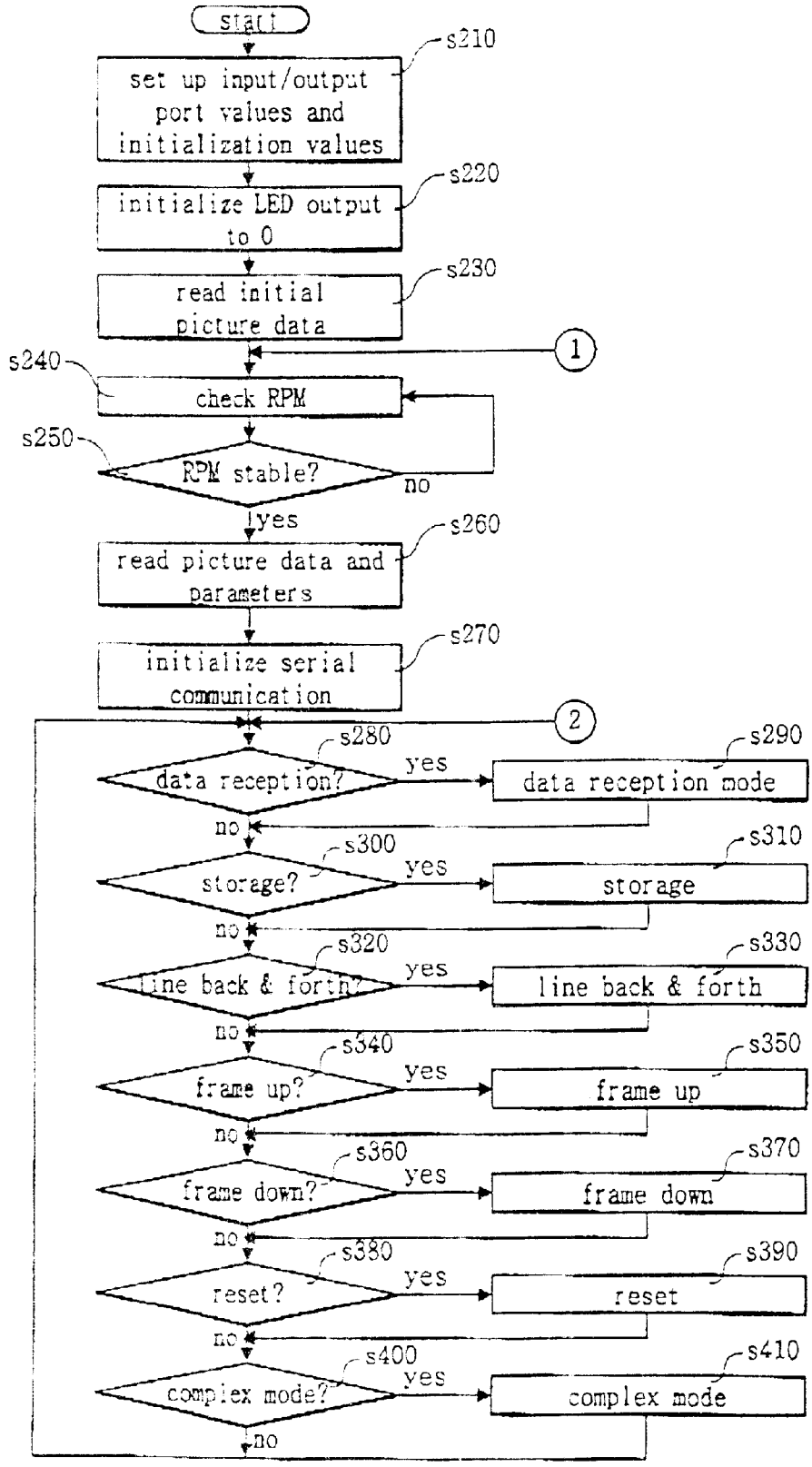

start
s210
set up input/output port values and initialization values
s220
initialize LED output to 0
s230
read initial picture data
1
s240
check RPM
s250
RPM stable?
no
yes
s260
read picture data and parameters
s270
initialize serial communication
2
s280
data reception?
yes
s290
data reception mode
no
s300
storage?
yes
s310
storage
no
s320
line back & forth?
yes
s330
line back & forth
no
s340
frame up?
yes
s350
frame up
no
s360
frame down?
yes
s370
frame down
no
s380
reset?
yes
s390
reset
no
s400
complex mode?
yes
s410
complex mode
no

Fig. 17b

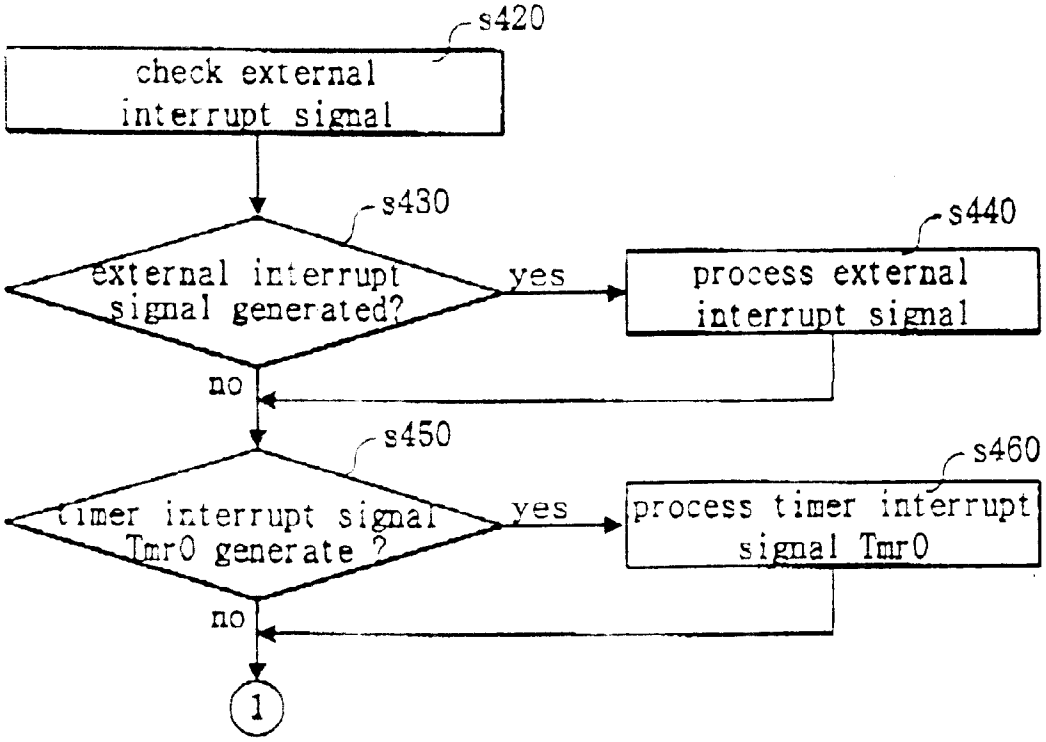

s420
check external interrupt signal
s430
external interrupt signal generated?
yes
s440
process external interrupt signal
no
s450
timer interrupt signal Tmr0 generate ?
yes
s460
process timer interrupt signal Tmr0
no
1

Fig. 17c

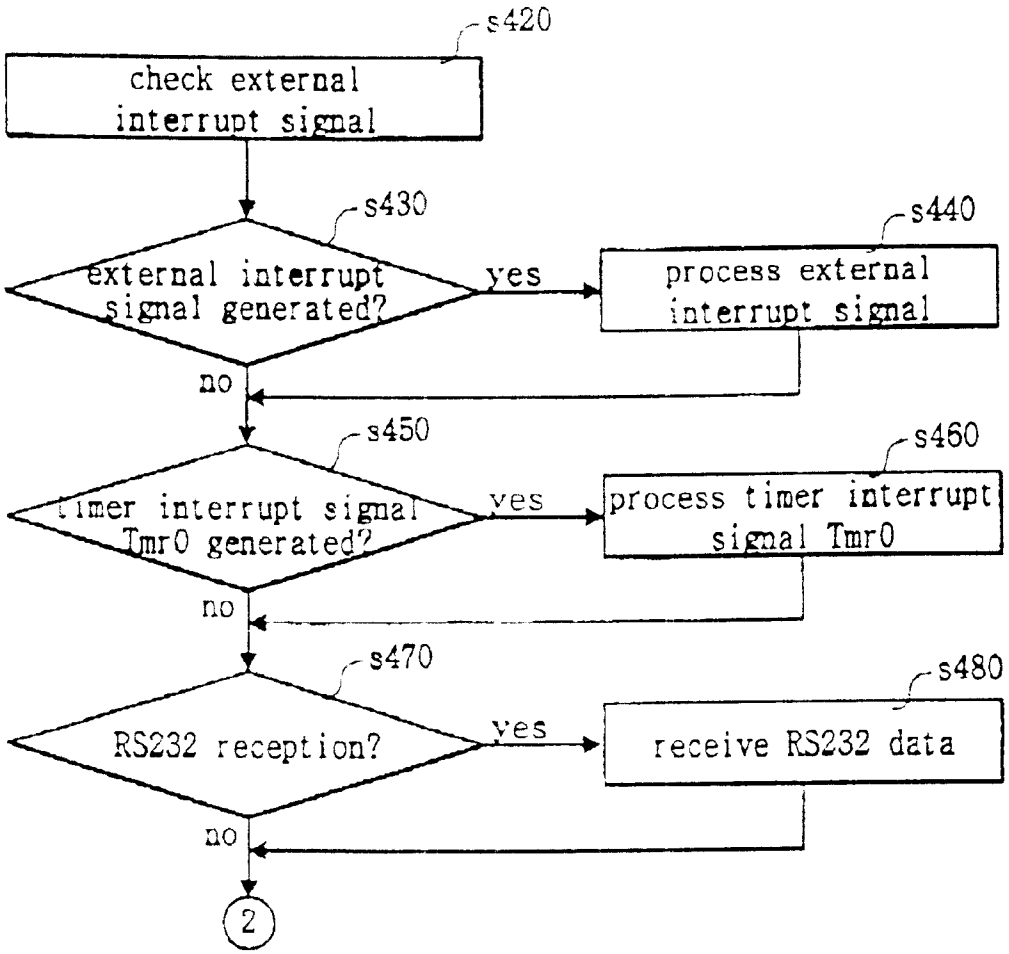
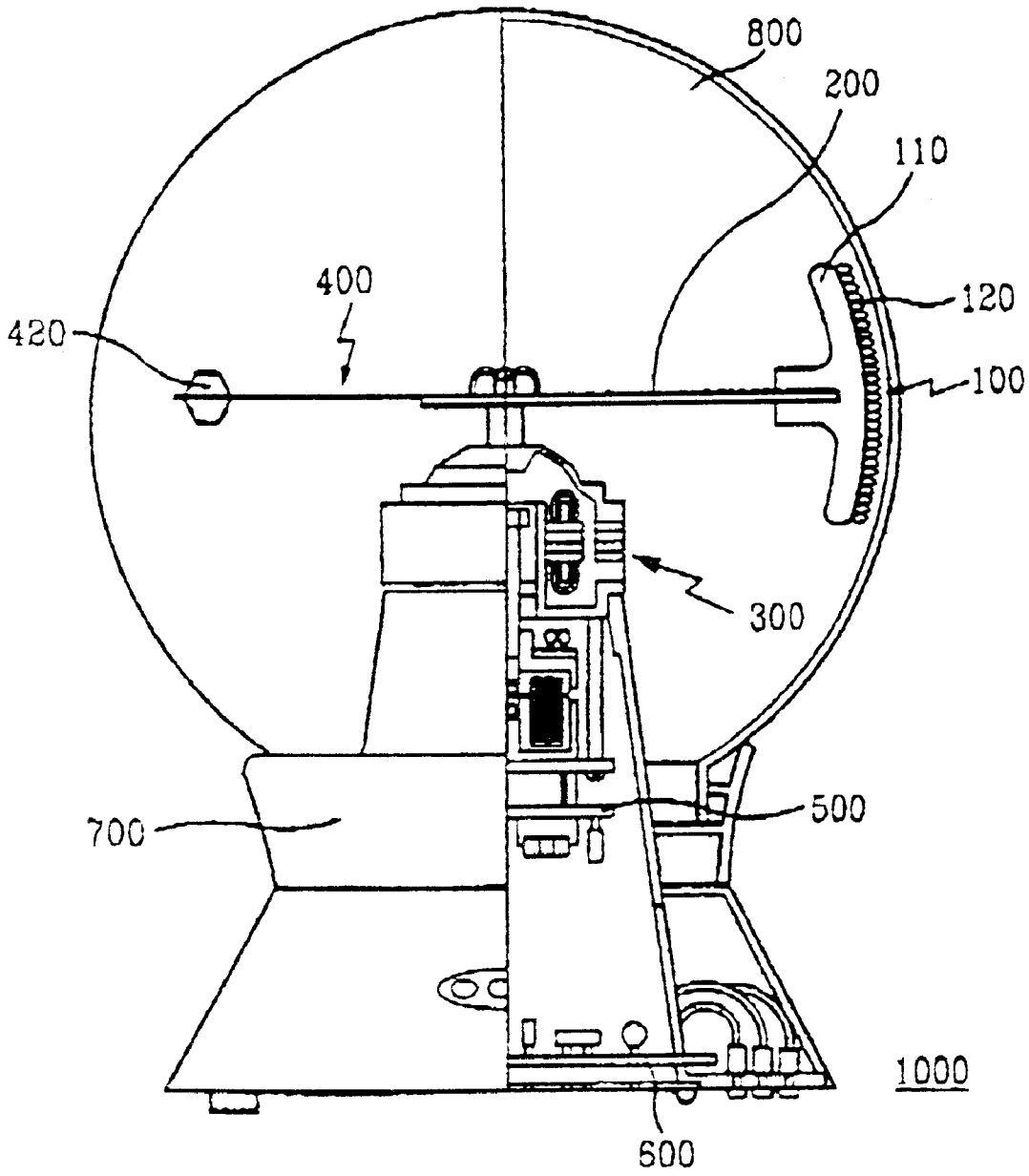

s420
check external interrupt signal
s430
external interrupt signal generated?
yes
s440
process external interrupt signal
no
s450
timer interrupt signal Tmr0 generated?
yes
s460
process timer interrupt signal Tmr0
no
s470
RS232 reception?
yes
s480
receive RS232 data
no
2

Fig. 18



METHOD AND APPARATUS FOR DISPLAYING CHARACTERS AND/OR IMAGES

TECHNICAL FIELD

The present invention relates to a method and an apparatus displaying characters and/or images using the rotation of light emitting diodes (LEDs), and more specifically, to an apparatus for displaying a bit map image from a basic display unit of 24 dots (vertical)×256 dots (horizontal)×1 (color) up to a display unit of 64 dots×512 dots×3 (full color) or more.

BACKGROUND ART

A conventional image display apparatus is shown in PCT Application No. PCT/EP97/03145, filed on Jun. 17, 1997 by Lumino Company in Germany. This image display apparatus comprises a casing made of a transparent and/or semi-transparent material, which contains an electric motor. The electric motor has a rotary shaft rotating around a symmetry axis. Rotatably mounted to the motor shaft is a rotary wing assembly on which a series of LEDs are attached in the vertical direction of the motor shaft.

The conventional image display apparatus further comprises a logic control board for controlling the above LEDs, and a photoelectronic measurement device for measuring a rotation speed of the rotary wing assembly. The photoelectronic measurement device includes a transmitter/receiver unit mounted to a rotary part of the apparatus at its one end and to a stationary part of the apparatus at its other end, both ends being spaced at a short distance from each other and facing each other at the opposite sides.

The conventional image display apparatus further comprises a mechanical balance unit provided at a position symmetrically opposite to the rotary wing assembly. The balance unit has an arbitrary sectional area and may preferably be a bar adjustable in length. The conventional apparatus keeps its balance by adjusting the length of the bar, which maintains its horizontal state while the motor rotates, or while the apparatus is operated.

This display apparatus is adapted to display a bit map image in a basic display unit of 16 dots (vertical)×256 dots (horizontal)×1 (color). Further, the apparatus is disadvantageous in that it provides no color expression and is very short in life due to mechanical defects. The motor shaft of the display apparatus is asymmetrical around the symmetrical axis.

Another conventional technique related to the image display is disclosed in Japanese Patent Laid-open Publication No. Heisei 2-61693 (Mar. 1, 1990), which shows a contactless energy transfer technique for supplying power from a generator to a control unit.

Another conventional technique related to the image display is disclosed in PCT Application No. PCT/EP98/00284, filed on Jan. 20, 1998 by Lumino Company in Germany, which shows a display apparatus wherein the transfer of energy to a logic control unit for control of LEDs is conducted in a contactless induction manner as in the above Japanese publication. This display apparatus is desirable to use a generator, transformer or electrostatic capacitor for the energy transfer, but has a disadvantage in that it has no feedback arrangement for accurately performing the energy transfer.

The above display apparatus employs a pole shading motor, which is simple in construction, but low in efficiency, resulting in a large amount of heat being generated. The pole shading motor further employs a light amateur as its rotor, thereby exhibiting a severe variation in its rotation speed due to an air resistance or weight even after it reaches a predetermined speed.

The above conventional display apparatus further comprises a serial electrically erasable and programmable read only memory (EEPROM) as a backup memory for storing data to be displayed by the logic control unit for the control of the LEDs. As a result, a larger amount of data to be stored increases the amount of memory load and, in turn, a processing time.

FIG. **1***a* is a front view of a conventional LED, indicated by the reference numeral **120**. As shown in this drawing, the LED **120** consists of three parts, a head **122**, a flange **124** and legs **126**, configured in one LED chip, and is of a single-color type. In the case where a plurality of LEDs, for example, sixteen LEDs, each of which is the LED **120**, are mounted to a rotary wing assembly, the adjacent ones of them have a gap therebetween resulting from the flanges **124** over the legs **126**, which leads to a reduction in resolution, thereby making it impossible to express a fine image or characters. Further, adjacent pads cannot help being arranged apart from each other at a distance resulting from the flanges **124**, thereby causing the LEDs **120** to be arrayed on both sides of the pads. Here, the pads signify copper foils on which the LED legs **126** are soldered and fixed.

In a conventional display apparatus, a logic control unit is inserted into a motor shaft via a hole. This hole is not positioned in the center of the circular portion but leans toward the rear of the circular portion, and this circular portion has no cover, thereby making it difficult to assemble the apparatus.

Further, the conventional display apparatus is adapted to adjust the length of a balance plate so as to keep its balance during its rotation. Also, the motor body is not rotated symmetrically about the motor shaft. Moreover, only the logic control unit is coupled with the motor shaft such that it rotates.

The conventional display apparatus comprises a transmitter and a receiver mounted to the lower part of the logic control unit separately from each other. This apparatus further comprises a reflector mounted to its stationary part. With this construction, the logic control unit is adapted to detect a light beam reflected by the reflector. As a result, a photoelectronic measurement device of this display apparatus is degraded in performance due to noise, etc., as compared with a transmission-type device.

Conventionally, a secondary voltage is generated and transferred either in a contact manner or in a contactless manner. A contact-type secondary voltage generation/transfer method, for example, a brush method is adapted to transfer an external direct current (DC) supply voltage to a secondary side through a contact surface of a brush. A contactless-type secondary voltage generation/transfer method, for example, a generator method is adapted to utilize a voltage induced in a generator with rotation as a secondary voltage. In this case, the generator acts as a converter for converting an alternating current (AC) voltage into a DC voltage. Also, a regulator is used to convert a voltage of +8V or more into a voltage of +5V. However, in the contactless-type method, a secondary voltage is not induced under the condition of no rotation, which leads to a reduction in rotation speed and occurrence of noise when the amount of load on the secondary side is increased. Therefore, it is impossible to raise the resolution by increasing the number of LEDs and, in turn, the number of dots.

In the contact-type secondary voltage generation/transfer method, no distinction is made between a primary voltage and a secondary voltage. The contactless-type secondary voltage generation/transfer method employs a personal computer (PC) serial communication port for inputting external data.

The conventional display apparatus has no front board acting as a keyboard. Further, this apparatus has a unitary body and a display bulb colored only brown.

DISCLOSURE OF THE INVENTION

Therefore, it is an object of the present invention to provide a method and an apparatus for displaying characters and/or images to overcome the above problems.

In accordance with one aspect of the present invention, the above and other objects can be accomplished by a provision of a character and/or image display apparatus, comprising a rotary wing assembly consisting of a plurality of light emitting diodes (LEDs) and a rotary wing; a logic control unit controlling the LEDs of the rotary wing assembly to allow the LEDs to display desired characters and/or desired images; a balance unit consisting of a balance plate and a balance weight, the balance unit being assembled with the logic control unit at a position opposite to the rotary wing assembly so as to accomplish a desired balance of the rotary wing assembly regardless of a difference in the center of gravity between the rotary wing assembly and the logic control unit during a rotating action of the rotary wing assembly; a motor unit consisting of a stator, a rotor, a hollow motor shaft having an axial passage and extending through both the stator and the rotor and being connected to both the rotor and the logic control unit at its opposite ends so as to rotate the rotary wing assembly, the logic control unit and the balance unit at the same time by a rotating force of the rotor, and a rotor holder used for locking the logic control unit to the motor shaft; a switch mode power supply (SMPS) used for supplying a direct current (DC) power to the logic control unit in a contactless manner, and mounted to a lower end of the motor shaft so as to be rotatable together with the motor shaft at the same time, the SMPS consisting of a primary board and a secondary board, the primary board transmitting both external alternating current (AC) voltage and external input data to the secondary board, and the secondary board being electrically connected to both the rotary wing assembly and the logic control unit through electric wires passing through the axial passage of the hollow motor shaft, thus transmitting the power and data to both the rotary wing assembly and the logic control unit; a data communication unit consisting of a modem board and an RS-232 board, and being used for transmitting external input data to the logic control unit; a display bulb covering the top of the rotary wing assembly, the logic control unit and the motor unit while forming a sealed space in the bulb, the display bulb allowing a user to observe characters and/or images displayed by the LEDs from the outside of the bulb; and an external casing mounted to a lower end of the display bulb and encasing the motor unit, the SMPS and the data communication unit.

The logic control unit of the present invention may include a micro controller; a backup memory for storing data necessary to the operation of the display apparatus, the backup memory being of a nonvolatile type; a working memory for reading the data stored in the backup memory; a data latch buffer for latching data from the working memory by a predetermined number of vertical dots; a latch clock generator for supplying clock data to the data latch buffer in response to an input/output control signal from the micro controller; an LED data driver for reading data from the data latch buffer in response to the clock data from the latch clock generator; and an LED array for displaying data under control of the LED data driver.

Preferably, the balance between the rotary wing assembly and the logic control unit may be accomplished by adjusting the weight of the balance weight, and the balance weight may be covered with a balance weight cover at its top and bottom, thus being prevented from undesirably coming into contact with the display bulb or from scratching the display bulb during an assembling process of the display apparatus.

Each of the LEDs, preferably, may be free from a flange radially projecting outward from a sidewall of an LED mold of each LED and have one or more LED chips arrayed in one LED mold in a horizontal, vertical, diagonal, or triangular arrangement.

The logic control unit may be covered with a cover at its circular end portion to reduce noises and air resistance during a rotating action of the logic control unit, and the SMPS may be of a flyback type where a secondary side of the SMPS is turned on when a primary side thereof is turned off, and include an AC input unit; a DC converter for converting an AC voltage from the AC input unit into a DC voltage; a pulse width modulation (PWM) control/generation circuit for controlling the output of the DC voltage converted by the DC converter to generate a high voltage; a high voltage/low voltage converter for converting the high voltage from the PWM control/generation circuit into a low voltage; a smoothing circuit for smoothing the low voltage converted by the high voltage/low voltage converter; and an output voltage detector for detecting a voltage signal from the smoothing circuit and transferring the detected voltage signal to the PWM control/generation circuit.

The balance weight may be a screw-type balance weight or a compression-type balance weight.

The motor unit may be an induction motor unit, being rotatable at the same time with the stator and a motor casing of the motor unit being rotatable at the same time while accomplishing a rotational symmetry around the hollow motor shaft.

An electric wire and a data communication wire from the secondary board of the SMPS may pass through the passage of the hollow motor shaft prior to being connected to the logic control unit.

Further, preferably, the secondary board of the SMPS may be provided with a transparent optical sensor unit, the sensor unit being integrally formed with a light emitting part and a light receiving part for sensing both a rotating velocity of the rotor of the motor unit and an initial rotating point of the rotor.

An optical transistor may be mounted to a central position of a ferrite core, the optical transistor being used for optically receiving a variety of data transmitted through a power feedback signal IR (infra-red) of the secondary board of the SMPS or through a power feedback signal IR of the primary board of the SMPS.

The various data may be transmitted from cellular phones, pagers, FM tuners, digital radio systems, RS-232, modems, and keys.

The primary and/or the secondary ferrite core may be EE type formed in the shape of a circle or square.

The primary and/or the secondary ferrite core may form the secondary side of the EE or El core formed in the shape of a circle or square.

The primary and the secondary-side bobbins of the SMPS may be separated from each other, the secondary-side bobbin may be situated inside primary-side bobbin while being upwardly spaced somewhat apart from the primary-side bobbin, and the primary-side bobbin may be mounted to be fixed and the secondary-side bobbin is mounted to be rotated.

The primary and the secondary-side bobbins of the SMPS may be laterally spaced somewhat apart from each other, and the primary-side bobbin of the SMPS may be mounted to be fixed and the secondary-side bobbin of the SMPS may be mounted to be rotated.

The modem board may be connected to external communication means via stereo- or mono-phone jacks, the stereo- or mono-phone jacks being mounted on the inside-support bracket.

In accordance with another aspect of the present invention, there is provided a character and/or image display method comprising the steps of a) applying power to a character and/or image display apparatus and setting up input/output port values and initialization values; b) initializing all LED values and clearing a screen; c) reading initial picture data from a nonvolatile backup memory; d) writing the data read from the backup memory into a working memory; e) reading initialization data from the working memory; f) displaying an initial picture and performing a still mode until a rotation speed of a motor becomes stable; g) reading data other than the initialization data from the working memory; h) sequentially performing modes corresponding to commands contained in the read data; and i) repeating the above steps g) and h) until all commands stored in the working memory are processed.

Preferably, the commands may include a data reception command, a data storage command, a line back & forth command, a frame up command, a frame down command, a reset command and a complex command.

As described above, the method and the apparatus for displaying characters and/or images of this invention has the improved operational effect as follows:

1. This apparatus and method of this invention effectively displays data using bitmap images.

2. In the apparatus and method of this invention, one or three LED chips are mounted to one LED, and so it is possible to increase the number of LED chips mounted within the same area in comparison with conventional apparatuses and methods, thus displaying beautiful characters and/or images in a variety of colors.

3. The logic control unit **200** is covered with a cover **260**, and so it is possible to overcome the problem caused by an air resistance and to accomplish a central beam scanning effect.

4. It is possible for the apparatus and method of this invention to accomplish a desired balance of the rotary wing assembly by properly controlling the weight of the balance weight **420**.

5. The motor unit is an induction motor unit, with the rotor of the motor unit accomplishing a rotational symmetry around the motor shaft **330**. In addition, the motor stator **320** integrated with the motor casing is used as the rotor **310** of the motor, while an armature is used as the motor stator **320**. Such an induction motor is remarkably improved in its operational efficiency in comparison with pole shading motors, and has an improved flywheel effect, thus being less likely to be changed in its rotating velocity. In addition, the motor shaft **330** is a hollow shaft defining an axial passage and allowing an electric wire to pass through.

6. In the apparatus of the present invention, the secondary-side power is produced by the SMPS using a feedback signal.

7. In addition, the feedback signal and bitmap image data of the SMPS are transmitted from the center of the ferrite core designed to accomplish a rotational symmetry.

8. In the apparatus and method of the present invention, the ferrite core and bobbin between the primary and secondary boards of the SMPS are locked together while desirably reducing a leakage of current in comparison with the prior art.

9. The secondary board of the SMPS is provided with a transparent optical sensor unit **511**, which is integrally formed with a light emitting part and a light receiving part for sensing both the rotating velocity of the motor rotor and the initial rotating point of the rotor. It is thus possible to easily install the sensor unit in the apparatus. The sensor unit is also less likely to be influenced by external noises and has a high response velocity.

10. The apparatus has an expected life span longer than that of conventional apparatuses, and is not likely to be changed in its rotating velocity regardless of a change in load.

11. It is possible for the apparatus of this invention to easily and simply fabricate the circuit of the logic control unit **200** since the apparatus uses the SMPS.

12. The apparatus has a high efficiency, and so it preferably generates a small amount of heat and is less likely to allow a leakage of current, thus being reduced in its power consumption.

13. The apparatus has a high brightness and a high resolution, and so it has a bright and clear display surface.

14. In the apparatus, the motor can be usable semipermanently.

15. Since the apparatus of this invention is preferably reduced in its power consumption, it saves money for power costs.

16. In the apparatus of this invention, a memory, having both the SRAM function and the EEPROM function, is used as the backup memory, and so it is possible for the apparatus to effectively perform a parallel data processing operation. Therefore, the apparatus can quickly process the data without requiring a memory having an enlarged capacity even though it is necessary to process a very large quantity of data.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1***a* is a front view of a conventional LED;

FIG. **1***b* is a front view of an LED in accordance with the present invention;

FIG. **1***c* is a sectional view of an LED in accordance with the present invention;

FIG. **2** is a front view of a character and/or image display apparatus in accordance with the preferred embodiment of the present invention;

FIG. **3** is a detailed diagram of a rotary wing assembly in accordance with the present invention;

FIG. **4** is a view showing the coupling between an LED and a printed circuit board (PCB) in accordance with the present invention;

FIGS. **5**(*a*) and **5**(*b*) are a detailed diagram of a logic control unit in accordance with the present invention;

FIG. **6** is a block diagram showing a circuitry of the character and/or image display apparatus in accordance with the preferred embodiment of the present invention;

FIGS. **7**(*a*), **7**(*b*) and **7**(*c*) are a view showing the constructions of a balance plate, balance weight and balance weight cover in accordance with the present invention;

FIG. **8** is a view showing the construction of a motor in accordance with the present invention;

FIG. **9** is a view showing the construction of a secondary board of a switch mode power supply (SMPS) in accordance with the present invention;

FIG. **10** is a detailed diagram of the secondary board of the SMPS in FIG. **9**;

FIG. **11** is a view showing a layout of a transmission-type optical sensor in accordance with the present invention;

FIGS. **12**(*a*), **12**(*b*) and **12**(*c*) are a view showing constructions of primary and secondary bobbins of the SMPS in accordance with the present invention;

FIG. **13** is a view showing the construction of a first board of a primary board of the SMPS in accordance with the present invention;

FIG. **14** is a view showing the coupling between the first board of the primary board of the SMPS and a second board thereof in accordance with the present invention;

FIG. **15** is a view showing the construction of an internal support body in accordance with the present invention;

FIG. **16** is a flowchart illustrating a character and/or image display method in accordance with the present invention;

FIGS. **17**(*a*), **17**(*b*) and **17**(*c*) are a detailed flowchart of the character and/or image display method in FIG. **16**; and

FIG. **18** is a front view of a character and/or image display apparatus in accordance with an alternative embodiment of the present invention.

MODE FOR CARRYING OUT THE INVENTION

In the present invention, all displayed data are bit map image data, which are displayed in a basic display unit of 24 dots (vertical)×256 dots (horizontal)×1 (color). The present invention is capable of displaying a bit map image up to a display unit of 64 dots×512 dots×3 (full color) or more using a switch mode power supply (SMPS) concept.

FIG. **2** is a front view of a character and/or image display apparatus in accordance with the preferred embodiment of the present invention, wherein the apparatus is denoted by the reference numeral **1000**. As shown in this drawing, the character and/or image display apparatus **1000** of the present invention comprises a rotary wing assembly **100**, logic control unit **200**, motor **300**, balance unit **400**, SMPS **500**, data communication unit **600**, external casing **700**, display bulb **800** and internal support body **900**. The constructions and operations of these components will hereinafter be described in detail with reference to the accompanying drawings.

FIG. **1***b* is a front view of an LED in accordance with the present invention. In the present invention, the LED **120** has no flange **124**, thereby enabling a larger number of LEDs **120** than the prior art to be mounted on the rotary wing assembly **100** of the character and/or image display apparatus **1000** so as to more finely express an image and/or characters. That is, owing to the absence of the flange **124**, the adjacent LEDs **120** have a minimum gap therebetween, resulting in an increase in resolution. Preferably, 24 to 64 dots may be vertically realized.

FIG. **1***c* is a sectional view of the LED **120** in accordance with the present invention. In this drawing, a circle indicates an LED mold **128** and a small rectangular portion in the circle indicates an LED chip **129**. The LED **120** may basically be classified into three types according to the layout of the LED chip **129**. The LED at the right part of FIG. **1***c* is a single LED having only one LED chip **129**, each of the LEDs at the center of FIG. **1***c* is a dual LED having two LED chips **129**, and each of the LEDs at the left part of FIG. **1***c* is a triple LED having three LED chips **129**. Among the triple LEDs, one having the LED chips **129** arranged in the horizontal direction provides a good color mixing effect and another having the LED chips **129** arranged in a regular triangle form provides a good productivity.

The dual and triple LEDs each have LED chips **129** arranged horizontally, vertically, triangularly or diagonally. The LED mold **128** preferably has a diameter of 3 mm or more. Further, the LED **120** can preferably express from a single color up to multiple colors.

FIG. **3** is a detailed diagram of the rotary wing assembly **100** in accordance with the present invention and FIG. **4** is a view showing the coupling between the LED **120** and a pad **112** in accordance with the present invention. As shown in these drawings, the rotary wing assembly **100** basically includes a wing **110**, pads **112** and **124** and a groove **116**.

In the rotary wing assembly **100**, pads **112** are provided at one end of an arrow-shaped wing to fix the LEDs **120** and a groove **116** is formed at the other end of the wing to couple the LEDs **120** with the logic control unit **200**. Pads **114** are provided around the groove **116** such that they are coupled with the logic control unit **200**.

In the present invention, the logic control unit is designed to have an area as small as possible to minimize an air resistance. Further, the logic control unit is designed to have the same round angle as that of the display bulb **800** to constantly maintain the gap between the ends of the LEDs **120** and the display bulb **800** upon assembling the LEDs **120**.

As seen from FIG. **4**, a printed circuit board (PCB) pad **112** is inserted between two or more LED legs **126** at one end of the wing **110** of the rotary wing assembly **100** such that it is integrated with the LED legs to fix them. Pads **114** are formed at the other U-shaped end of the wing **110** such that they are coupled with a U-shaped portion of the logic control unit **200** in a + form. The rotary wing assembly **100** may preferably have a four-layered structure. Similarly, the logic control unit **200** may preferably have a four-layered structure.

FIGS. **5***a* and **5***b* show different constructions of the logic control unit **200** in accordance with the present invention. The logic control unit **200** includes a controller **260**, which may preferably have a circular structure as shown in FIG. **5***a* or a rectangular structure as shown in FIG. **5***b*. A description will hereinafter be given of the logic control unit **200** including the circular controller **260** as an example.

The controller **260** is installed to be symmetrically rotatable about a motor shaft **330**. A U-shaped groove **220** is formed in the front portion of the logic control unit **200** such that it is engaged with the groove **116** of the rotary wing assembly **100**, and threaded holes **250** are formed in the rear portion of the logic control unit **200** such that they mount a balance plate **410** to the logic control unit **200** therethrough. The balance plate **410** is provided to keep the balance of the display apparatus during its rotation. A plurality of signal connection pads, preferably, twenty-four pads **210** are provided around the groove **220**, to which pads of the rotary wing assembly **100** are connected vertically or horizontally.

The logic control unit **200** performs a parallel processing of data to be displayed by LEDs. This unit **200** is inserted into the motor shaft **330** through a hole **230** formed at its center. Threaded holes **240** are formed at the left and right portions of the hole **230** for coupling with a stationary body of a rotor. Connectors are installed on the top of the controller **260** to mount extended boards to the controller **260**. A cover **265** is mounted to the logic control unit **200** in consideration of an air resistance. This cover **265** may preferably be of a locker type or a screw type.

FIG. **6** is a block diagram showing a circuitry of the character and/or image display apparatus in accordance with the preferred embodiment of the present invention. As shown in this drawing, the character and/or image display apparatus of the present invention comprises a logic control unit **200**, SMPS **500**, data communication unit **600** and front board **700**.

The logic control unit **200** includes a micro controller **270**, a backup memory **295'** which is a nonvolatile memory for storing data necessary to the operation of the display apparatus, a working memory **295** for reading the data stored in the backup memory **295'**, a data latch buffer **290** for latching data from the working memory **295** by a predetermined number of vertical dots, a latch clock generator **280** for supplying clock data to the data latch buffer **290** in response to an input/output (I/O) control signal from the micro controller **270**, an LED data driver **285** for reading data from the data latch buffer **290** in response to the clock data from the latch clock generator **280**, and an LED array **296** for displaying data under control of the LED data driver **285**.

In other words, the logic control unit **200** employs one or more central processing units (CPUs) to receive external data and display desired data at a desired position through LEDs. If the logic control unit **200** is powered on, then data to be displayed is transferred from the backup memory **295'** to a mapping area of the working memory **295**. Then, the data latch buffer **290** latches data from a default bank area of the working memory **295** by a predetermined number of vertical dots (the number of data per line) in response to the clock data from the latch clock generator **280** to display them through LEDs. Thereafter, in response to a data enable clock being toggled, the LED data driver **285** displays the data latched by the data latch buffer **290** through LEDs.

External data and commands are transferred through a serial communication port and stored in the backup memory **295'**. Desired data is displayed through LEDs using the data and commands stored in the backup memory **295'**, as stated above.

The micro controller **270** is operated to display data stored in the working memory **295** through LEDs. The working memory **295** stores all data to be displayed and is one-to-one mapped to the backup memory **295'**. In the present embodiment, the working memory **295** may be a static random access memory (SRAM).

The micro controller **270** also acts to control areas (i.e., the backup memory **295'** and working memory **295**) storing data to be displayed through LEDs. Whereas the micro controller **270** refers to the working memory **295** in operation, it refers to the backup memory **295'** upon application of power. Upon application of power, the micro controller **270** transfers data from the backup memory **295'** to the working memory **295** and then begins to operate. In the present embodiment, the backup memory **295'** may be an EEPROM.

In order to display data stored in the working memory **295** through LEDs, the micro controller **270** can access eight data bits at a time. For this reason, the micro controller **270** must gain access to the working memory **295** four times to drive 32-dot LEDs. At this time, respective data access time points are different, resulting in the same line being misaligned on a 8-dot basis. For the purpose of preventing this problem, the data latch buffer **290** has a two-stage structure. Namely, the data latch buffer **290** performs its original data latch function at the first stage and a one-line simultaneous active function at the second stage, respectively. Alternatively, the data latch buffer **290** may perform only the first stage function. In this case, the LED data driver **285** may perform the second-stage function.

The latch clock generator **280** is adapted to generate a control signal to latch or enable data in the data latch buffer **290** and LED data driver **285** when the micro controller **270** accesses data stored in the working memory **295** to display it through LEDs.

The LED array **296** is an LED display module which is capable of expressing data to be displayed by the micro controller **270** in the form of light beams.

Now, a more detailed description will be given of the operation of the character and/or image display apparatus with the above-mentioned construction in accordance with the present invention. The present invention is characterized in that desired data is displayed at a desired position using a man's optical illusion phenomenon occurring with rotation of a vertical array of LEDs at a speed of about 3600 rpm.

For a rotation speed of 3600 rpm, a time period of 16.67 msec is required per one rotation. The length of the logic control unit **200** is 14.3 cm, which is a radius of rotation. The resulting circumferential locus is 89.45 cm.

For 32 3 mm-sized LEDs arrayed, the size of a vertical display area is 96 mm for single-color expression. For 24 4 mm-sized LEDs arrayed, the size of a vertical display area is similarly 96 mm for multicolor expression.

The size of a horizontal display area is 913 mm for 256 dots. In the case where 32×32 fonts are displayed in a square form, the size of a vertical display area becomes 96 mm and the number of displayable fonts becomes 9.5 characters. In this case, the size of a horizontal display area becomes 330 dots.

Because a time period of 65.2 μsec is required to display one line in the vertical direction, a horizontal dot interval becomes 3.57 mm.

The size of data per frame is 1024 bytes for single-color expression and 3072 bytes for three-color expression. A memory size is 32 Kbytes. The total number of frames is 32 for single-color expression and 10.7 for three-color expression.

On the other hand, the SMPS **500** of the present invention is an ON/OFF-type SMPS, which is also of a flyback type wherein a secondary side of the SMPS **500** is turned on when a primary side thereof is turned off. The SMPS **500** includes an AC input unit **501**, a DC converter **502** for converting an AC voltage from the AC input unit **501** into a DC voltage, a pulse width modulation (PWM) control/generation circuit **503** for controlling the output of the DC voltage converted by the DC converter **502** to generate a high voltage, a high voltage/low voltage converter **506** for converting the high voltage from the PWM control/generation circuit **503** into a low voltage, a smoothing circuit **505** for smoothing the low voltage converted by the high voltage/low voltage converter **506**, and an output voltage detector **504** for detecting a voltage signal from the smoothing circuit **505** and transferring the detected voltage signal to the PWM control/generation circuit **503**. Here, the AC input

unit **501**, DC converter **502**, PWM control/generation circuit **503** and high voltage/low voltage converter **506** are provided at the primary side of the SMPS **500** and the smoothing circuit **505** and output voltage detector **504** are provided at the secondary side of the SMPS **500**.

All communication data and sensor signal outputs from the SMPS **500** are inputted to the micro controller **270** in the logic control unit **200**. Also, all communication data outputs from the logic control unit **200** to the SMPS **500** originate from the micro controller **270**.

If an AC voltage is inputted by the AC input unit **501**, then it is converted by the DC converter **502** into a DC primary voltage with a magnitude higher than the input voltage by 2 times. This converted DC voltage is applied to the PWM control/generation circuit **503**. The output voltage detector **504** detects an output voltage from the smoothing circuit **505** and outputs a low signal to the PWM control/generation circuit **503** if the detected voltage is lower than a reference voltage (5.0 to 5.3V). In response to the low signal from the output voltage detector **504**, the PWM control/generation circuit **503** increases a duty ratio of its output voltage. In the opposite case to the above, the PWM control/generation circuit **503** reduces the duty ratio of its output voltage through the same path as the above.

The high voltage/low voltage converter **506** is a kind of transformer, which induces a low voltage in its secondary coil in response to a high voltage in its primary coil. This induced AC voltage is converted into a DC voltage by removing a negative voltage component therefrom. This converted DC voltage contains a ripple component, which is then removed by the smoothing circuit **505**. As a result, a voltage of 5V is supplied to the logic control unit **200**.

The output voltage detector **504** transfers the state of an output voltage from the smoothing circuit **505** to the PWM control/generation circuit **503**. In the case where the output voltage from the smoothing circuit **505** is lower in level, an infrared (IR) beam from the output voltage detector **504** is lower in intensity, too, and a phototransistor is increased in discharging time. At this time, the PWM control/generation circuit **503** senses the amount of collector-emitter current of the phototransistor and increases the duty ratio of its output voltage and, thus, its level as a result of the sensing.

The data communication unit **600** includes a transmitter and a receiver. The transmitter converts data of an RS-232C level from a PC into a TTL level and transmits it to the front board **710**. The transmitter receives commands and modem data of the TTL level processed by the front board **710** and converts them into the RS-232C level for the driving of an IR beam.

The IR beam driven in the transmitter is received by the receiver through the phototransistor. This received signal contains a large amount of noise. As a result, the received signal is noise-removed and then transferred to the logic control unit **200**.

FIG. 7*a* shows a balance plate **410**, FIG. 7*b* shows two balance weights **420**, and FIG. 7*c* shows a balance weight cover **430**. In the present invention, it is preferred to make the balance plate **410**, the balance weights **420** and the balance weight cover **430** using an elastic metal or a plastic material having high elasticity. The balance unit **400** comprises the balance plate **410**, the balance weights **420**, and the balance weight cover **430** covering the top and bottom of the balance weights **420**. The above balance weight cover **430** is used for preventing the balance weights **420** from undesirably coming into contact with the display bulb **800** during an assembling process of the display apparatus **1000** thus preventing the surface of the bulb **800** from being scratched. In FIG. 7(*b*), a screw-type balance weight is shown at the right side of the drawing, while a compression-type balance weight is shown at the left side.

Two first holes **440** are formed at one end portion of the balance plate **410** for locking the logic control unit **200** to the plate **410**, while one second hole **450** is formed at the other end portion of the plate **410** for locking the weight **420** made of steel, lead or rubber to the plate **410**. The cover **430** covers the top and bottom of the balance plate **410**. The above balance unit **400** is used for accomplishing a desired balance of the rotary wing assembly **100** regardless of a difference in the center of gravity between the wing assembly **100** and the logic control unit **200** during a rotating action of the wing assembly **100**.

FIG. **8** shows the motor unit **300**. As shown in the drawing, the motor unit **300** is an induction motor, of which the stator **320** is designed to be rotatable. This motor unit **300** consists of a rotor **310**, a stator **320**, a hollow motor shaft **330**, a longitudinal passage **340**, a fixed mount **360** and a logic control mount **350**. The above passage **340** is longitudinally formed along the central axis of the motor shaft **330**. The fixed mount **360** is used for mounting the secondary board of the SMPS (switch mode power supply).using a secondary-side fixing holder. The logic control mount **350** is used for mounting the logic control unit **200** using a rotor-fixing holder (not shown).

The above rotor-fixing holder is firmly fixed to a shaft insert hole of the motor shaft **330**, and has first and second screw holes. In such a case, the first screw hole of the rotor-fixing holder fixes and holds the logic control unit **200** during a rotating action of the unit **200** while maintaining a desired balance of the unit **200** without allowing the unit **200** to be undesirably moved. The second screw hole is used for mounting the rotor-fixing holder to the motor shaft **330**. The above rotor-fixing holder accomplishes a rotational symmetry around the motor unit **300**.

A plurality of heat dissipating holes are formed on the external surface of the rotor **310**, while a support connector is provided on the stator **320** for firmly connecting the ground terminal connector to the first board of the primary board of the SMPS.

The motor shaft **330** is connected to the rotor **310**, with the passage **340** formed along the central axis of the shaft **330**. An electric wire and data communication wire from the secondary board of the SMPS pass through the passage **340** of the motor shaft **330** prior to being connected to the logic control unit **200**, thus supplying electric power and transmitting data from the SMPS to the logic control unit **200**.

The logic control unit **200** and the secondary board of the SMPS are connected to the upper and lower ends of the motor shaft **330**, and so the rotor **310** together with the motor shaft **330** is rotated when the motor unit **300** is activated. Due to the rotating action of the motor shaft **330**, the other parts of the motor unit **300** are rotated by the rotating force of the motor shaft **330** at the same time.

The motor used in the display apparatus of this invention is an induction motor, with an armature used as a stator, and a stator used as a rotor. Such an induction motor is complex in its construction and is difficult in its fabricating process in comparison with a pole shading motor. However, the induction motor preferably has a high efficiency, and so it desirably generates a small quantity of heat. Since the induction motor also uses a heavy stator as its rotor, the motor is less likely to be markedly changed in its rotating velocity, regardless of an air resistance or its own weight, once the

motor reaches a predetermined final rotating velocity. In addition, the motor unit **300** of this invention is designed to allow the stator to be rotatable together with the external casing of the motor unit at the same time, and so the weight of the rotor is increased to the maximum. Therefore, the rotor is improved in its flywheel effect. The rotating velocity of the rotor is thus less likely to be influenced by an air resistance or its own weight.

FIG. **9** shows the secondary board of the SMPS, FIG. **10** shows the construction of the secondary board of FIG. **9** in detail. As shown in the drawings, the secondary board **510** of the SMPS generally comprises a motor shaft holding unit **512**, a transparent optical sensor unit **511**, and an element mount unit. The motor shaft holding unit **512** receives the motor shaft **330**, thus holding the shaft **330**, while the transparent optical sensor unit **511** senses both the rotating velocity of the rotor **310** of the motor unit **300** and the initial point of the rotating rotor **310**. On the other hand, the element mount unit is used for mounting and holding the elements of the secondary board **510** of the SMPS.

In the present invention, the secondary board **510** of the SMPS is a printed circuit board (PCB) having a rectangular or circular profile, and is mounted to the motor shaft **330** while accomplishing a rotational symmetry around the shaft **330**. In the present invention, the PCB used as the secondary board **510** of the SMPS may be directly mounted to the motor shaft **330**. Alternatively, the PCB used as the secondary board **510** may be indirectly mounted to the shaft **330** using a separate holder or an adhesive agent. In addition, a ferrite core is mounted to the motor shaft in the same manner as that described for the PCB of the secondary board **510**.

FIG. **11** shows the transparent optical sensor unit **511** of the secondary board **510** of the SMPS. As shown in the drawing, the optical sensor unit **511** may be freely positioned on the secondary board **510** of the SMPS at any desired position in accordance with the position of a point designation tag **515** of the primary-size fixing holder **516** mounted to the stator **320** of the motor unit **300**. The above optical sensor unit **511** is a single body having a light emitting part **513** and a light receiving part **514**, with four lead wires **517** extending from one end of the sensor unit **511** and the secondary board **510** of the SMPS engaging with the lead wires **517**.

The above optical sensor unit **511** is fixed to the motor shaft **330** while being positioned on the secondary board **510** of the SMPS, and so the sensor unit **511** is rotatable together with the motor rotor **310**. This optical sensor unit **511** senses the point designation tag **515** of the stator **320** during a rotating action of the rotor **310**.

An optical transistor **521** is mounted to the central position of the ferrite core **518**. This optical transistor **521** optically receives a variety of data, such as digital data transmitted from cellular phones, pager phones, FM tuners, digital radio systems, RS-232, modems, or keys through the power feedback signal IR (infra-red) **520** of the secondary board **510** of the SMPS or through the power feedback signal IR of the primary board **530** of the SMPS. The above-mentioned parts are assembled with the second board **510** of the SMPS. In addition, the terminals of the bobbins **519** assembled with the ferrite cores **518** are connected to the secondary board **510** of the SMPS.

Although not illustrated in the drawings, the combination of the secondary-side ferrite core of the SMPS and the bobbin holder includes a motor shaft fitted portion, an electric wire connector portion, a ferrite core and a bobbin connector portion.

The bobbin holder is secured to the motor shaft **330**. The bobbin holder fixes the ferrite core connected with the secondary-side bobbin in its lower portion, and accommodates an IR **520** and a phototransistor **521** in its center portion. A secondary board **510** of the SMPS is mounted to the upper portion of the bobbin holder.

Accordingly, the secondary-side ferrite core of the SMPS and the bobbin holder allows the secondary board of the SMPS to be secured to the motor shaft **330**, and serves to cause the secondary board of the SMPS to be rotated together with the motor rotor **310** while the motor is rotated. The secondary-side ferrite core forms the secondary side of an EE or EI type core formed in the shape of a circle or square, and is made of power transmitting material. The combination of the secondary ferrite core of the SMPS and the bobbin holder form the secondary side of the SMPS along with the secondary board **510** of the SMPS, and is rotated.

The IR **520** and the phototransistor **521** of the secondary-side of the SMPS serve to transmit digital data, such as a power feedback signal, bitmap per frame image data and command data of the secondary-side board of the SMPS, and are mounted in the central cavity of the ferrite core by means of a holder.

FIG. **12** is view showing the primary-side and secondary-side bobbins in accordance with the present invention. In FIG. **12***a*, the secondary-side bobbin **540** of the SMPS is illustrated on the upper portion of the drawing, and the primary-side bobbin **548** is illustrated on the lower portion. A space in which coils are wound is provided between the primary-side and secondary-side bobbins **540** and **548**. Two ferrite core holes **542** and **546** are formed through the primary-side bobbin **540** and the secondary-side bobbin **548**, respectively.

The primary-side bobbin **540** and the secondary-side bobbin **548** are separated from each other. Accordingly, the secondary-side bobbin **540** is fixedly fitted around the secondary-side ferrite core and mounted by means of a holder, and the primary-side bobbin **548** is fitted around the primary-side ferrite core and mounted by means of a holder. Two manners of connecting the primary-side bobbin **548** and the secondary-side bobbin **540** exist, as shown in FIGS. **12***b* and **12***c*.

In accordance with a first manner, the secondary-side bobbin **540** is situated inside and overlapped with the primary-side bobbin **548** while being upwardly spaced somewhat apart from the primary-side bobbin **548**, the primary-side bobbin **548** is mounted to be fixed, and the secondary-side bobbin **540** is mounted to be rotated.

In accordance with a second manner, the secondary-side bobbin **540** is situated beside the primary-side bobbin **548** while being laterally spaced somewhat apart from the primary-side bobbin **548**, the primary-side bobbin **548** is mounted to be fixed, and the secondary-side bobbin **540** is mounted to be rotated.

FIG. **13** is a partial cross-section showing the primary board **530** of the SMPS. The board **530** serves to fixedly connect the primary ferrite core of the SMPS and the bobbin-fixing portion to each other, has a square or circular shape, and forms the primary side of the SMPS. Additionally, the board **530** has a pad to which the three pins of the AC input terminal of the motor are connected.

As depicted in FIG. **14**, the first board **530** of the primary side of the SMPS **530** is connected with the second board **535** of the primary side of the SMPS through a connector **536**, thus forming the primary side of the SMPS. The ferrite

core and the bobbin are fixed by means of a holder. An IR **531** and a phototransistor **532** held by a holder in the cavity situated in the center portion of the ferrite core are connected to these portions. Although not illustrated in the drawings, this is fixedly connected to the stator **320** of a motor by means of a support.

In constructing the SMPS, the second board **535** of the primary side of the SMPS is a portion in which the remaining portion excepting portions ranging from an AC input to the connecting portion of the primary and secondary ferrites is mounted. The second board **535** of the primary side of the SMPS is connected to the first board **530** of the primary side of the SMPS to form the primary side of the SMPS, and transmits AC power input from the outside and digital data, such as bitmap image data and various command data input through external apparatus (such as a cellular phone, a radio pager, a FM tuner, a digital radio system, a remote controller or the like), to the secondary board **510** of the SMPS through the first board **530** of the primary side of the SMPS.

The IR **531** and phototransistor **532** of the primary side of the SMPS transmit data or a power feedback signal to and receive data or a power feedback signal from the IR **520** and phototransistor **521** of the secondary side of the SMPS, and are capable of transmitting and receiving data while being rotated. The IR **531** and phototransistor **532** of the primary side of the SMPS are mounted to a fixing holder for the ferrite core of the primary side of the SMPS and the bobbin-fixing portion.

The data communication unit **600** includes a modem board **610** and a RS232 board **620**. The modem board **610** is formed in the shape of a square or circle, and satisfies Modem Protocol Standard VIS.22. The modem board **610** supports basic modem protocol. The modem board **610** is connected to the second board **535** of the secondary side of the SMPS through a pin connector or wire.

As usual, the connection of a modem board **610** to external communication means is achieved by use of stereo- or mono-phone jacks, which are mounted on the inside-support bracket **900**. In this regard, the inside-support bracket **900** comprises a casing and an additional support body. Thus, external RS-232 data and model data are inputted through the stereo- or mono-phone jacks and outputted toward the telephone via telephone jacks.

The front board **710** (not shown), installed in the external casing **700**, has the function of multiplexing RS-232 data, modem data and/or key data through IC chips or analog switches or the like. In addition to being associated with key switches, the front board **710** is combined directly or via a wire to the modem board **610** for inputting and outputting data.

Turning now to FIG. **15**, there is shown an inside-support bracket **900**. This inside-support bracket **900** can be largely separated into an upper cylindrical member **920** and a lower disk member **930**. In the center of the cylindrical member **920**, a cavity **910** is provided for seating a motor. Facing each other, a pair of opposite grooves **980** for combining with the modem board **610** are set in the bottom of the upper member **920**, at which the lower member **930** is contacted with the upper member **920**.

On one side of the upper surface of the lower member **930**, a fuse holder **940**, an AC cord **950** and a plurality of connectors **960** for interfacing with external apparatuses lie adjacent to each other. Directed downwardly, a draft hole is provided in the center of the lower member **930**.

Preferably, the inside-support bracket **900** is made of iron, aluminum, plastic or the like. With the structure, the inside-support bracket **900** is associated with a motor stator **320** at the cavity **910**, with external apparatuses at the connectors **960**, and with the modem board **610** at the opposite grooves **980**. Also, wires can be connected to the inside-support bracket **900**. The cavity **910** in the center of the upper member **920** also accommodates an SMPS.

Installed in the inside-support bracket **900** are connectors, AC input cords, and fuse holders, said connectors connecting to connecting terminals of external communication means with the aim of transferring bitmap image data from and to RS-232 ports or modems of PC or external communication means (cellular phones, pagers, FM tuners, digital radio systems, etc). The inside-support bracket **900** is rotationally symmetrical on a motor shaft **330**.

The external casing **700** has a neck of a pinched, rectangular or trapezoidal shape, which is equipped with key buttons, a power on/off switch and function key switches. In an upper part of the external casing **700** is provided an assembling means through which the display bulb **800** is associated with the external casing **700** while the lower part of the external casing **700** is structured to combine with the inside-support bracket **900**.

Preferably made of colored polycarbonate or acryl, the display bulb **800** has a neck provided with several thread grooves at its lower part. The display bulb **800** is combined with the external casing **700** by rotationally fitting the neck into the assembling means of the external casing and fixing by use of screw spikes.

In the present invention, a Windows font is used to display characters and a picture board in the MS Windows 95 version or later is used to create data. Further, a bit map is used to display a desired image.

The logic control unit **200** contains a software module for displaying a variety of bit map image data through LEDs using a CPU or microcomputer.

The modem board **610** is adapted to receive modem protocol data or RS232C level data transmitted through an external telephone line using the CPU or microcomputer, convert the received data into bit map image data processible in the logic control unit **200** and transfers the converted bit map image data to the logic control unit **200**. The data communication unit **600** is adapted to communicate with the front board **710** having function keys.

In the present invention, the contactless-type SMPS is used to transfer electrical energy. The use of the contactless-type SMPS can reduce the amount of noise as compared with a conventional brush-type product or generator-type product.

The SMPS employs a ferrite core and bobbin, thereby causing a secondary voltage to be generated under the condition of no rotation and the rotation speed not to vary due to the amount of load on the secondary side. Further, as compared with the prior art, the circuitry is highly stable and the amount of voltage ripple is small.

FIG. **18** is a front view of a character and/or image display apparatus in accordance with an alternative embodiment of the present invention. This second embodiment is substantially the same in construction and operation as the first embodiment, with the exception that the external casing **700**, balance weight **420** and rotary wing assembly **100** have modified shapes.

FIG. **16** is a flowchart illustrating a character and/or image display method in accordance with the present invention. First, if the character and/or image display apparatus **1000** is powered on (s**110**), then the logic control unit turns off the

LEDs and clears the screen (s120). Thereafter, the logic control unit **200** reads all data stored in the nonvolatile backup memory **295'** (s130) and writes the read data into the working memory **295** (s140). Subsequently, the logic control unit **200** reads initialization data from the working memory **295** (s150), displays an initial picture and performs a still mode (s160). The logic control unit **200** reads data other than the initialization data from the working memory **295** (s170), processes the read data and performs a set mode (s180). Then, the logic control unit **200** repeats the above steps s170 and s180 until it processes all the data read from the working memory **295**.

In the present invention, data regarding the operating states of the character and/or image display apparatus, such as a moving state, blinking state, etc. are storable in the backup memory **295'**. The logic control unit **200** basically performs the still mode at the above step s160 and proceeds to the subsequent mode if the rotation speed of the motor becomes stable.

FIG. **17** is a detailed flowchart of the character and/or image display method in FIG. **16**. In FIG. **17***a*, first, if the display apparatus **1000** of the present invention is powered on, then the logic control unit **200** sets up input/output port values and initialization values (s210) and initializes the LED output to 0 (s220). Then, the logic control unit **200** reads initial picture data from the working memory **295** (s230). In this step s230, the logic control unit **200** reads data associated with only one frame from the working memory **295** and performs the steps s130 to s160 in FIG. **16**.

Thereafter, the logic control unit **200** checks the rpm of the motor (s240) to determine whether it is stable (s250). If the rpm of the motor is unstable, the logic control unit **200** repeats the above steps s240 and s250 until it becomes stable. In other words, the display apparatus displays the initial picture at the still mode until the rotation speed becomes stable.

If the rpm of the motor becomes stable, then the logic control unit **200** reads picture data and parameters stored in the working memory **295** (s260) and initializes the serial communication (s270). If the serial communication is initialized, then the logic control unit **200** processes modes based on programmed commands. That is, the logic control unit **200** checks a given command, performs the corresponding command, checks the subsequent command, performs the corresponding command and repeats this procedure (s280–s400). If a data reception command is given (s280), the logic control unit **200** performs a data reception mode (s290). In this manner, the logic control unit **200** performs a data storage mode (s310) if the given command is a data storage command (s300), a line back & forth mode (s330) if a line back & forth command (s320), a frame up mode (s350) if a frame up command (s340), a frame down mode (s370) if a frame down command (s360), a reset mode (s390) if a reset command (s380) and a complex mode (s410) if a complex command (s400), respectively.

In FIG. **17***b*, in the initial state of the operation of the present display apparatus, the logic control unit **200** checks whether there is an interrupt signal from an external component (sensor) (s420 and s430). The logic control unit **200** processes an external interrupt signal if it is present (s440) and checks whether there is a timer interrupt signal Tmr**0** indicative of an inter-dot time period if there is no external interrupt signal (s450). In the case where the timer interrupt signal Tmr**0** is present, the logic control unit **200** processes it (s460) and then proceeds to the above step s230 of reading the initial picture data (ⓞ).

FIG. **17***c* shows a procedure during communication or in the case where there is an interrupt signal from a sensor. After performing the above step s270 of initializing the serial communication, the logic control unit **200** checks whether an external interrupt signal is present at the above steps s280 to s400 (s420 and s430). The logic control unit **200** processes an external interrupt signal if it is present (s440) and checks whether there is a timer interrupt signal Tmr**0** indicative of an inter-dot time period if there is no external interrupt signal (s450). The logic control unit **200** processes the timer interrupt signal Tmr**0** in the case where it is present (s460). However, if the timer interrupt signal Tmr**0** is not present, the logic control unit **200** determines whether RS232 data has been received (s470) and receives the RS232 data (s480). In this manner, if an interrupt signal is generated at the above steps s280 to s400, then the logic control unit **200** stops the current task, stores it, processes the generated interrupt signal and then performs the stopped task again.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. An apparatus for displaying characters and/or images, comprising:

a rotary wing assembly consisting of light emitting diodes (LEDs) and a rotary wing;

a logic control unit controlling said LEDs of the rotary wing assembly to allow the LEDs to display desired characters and/or desired images;

a balance unit consisting of a balance plate and a balance weight, said balance unit being assembled with said logic control unit at a position opposite to the rotary wing assembly so as to accomplish a desired balance of said rotary wing assembly regardless of a difference in the center of gravity between said rotary wing assembly and said logic control unit during a rotating action of said rotary wing assembly;

a motor unit consisting of a stator, a rotor, a hollow motor shaft having an axial passage and extending through both said stator and said rotor and being connected to both the rotor and the logic control unit at its opposite ends so as to rotate the rotary wing assembly, the logic control unit and the balance unit at the same time by a rotating force of said rotor, and a rotor holder used for combining the logic control unit with the motor shaft;

a switch mode power supply (SMPS) used for supplying a direct current (DC) power to said logic control unit in a contactless manner, and mounted to a lower end of said motor shaft so as to be rotatable together with the motor shaft at the same time, said SMPS consisting of a primary board and a secondary board, said primary board transmitting both external alternating current (AC) voltage and external input data to said secondary board, and said secondary board being electrically connected to both the rotary wing assembly and the logic control unit through electric wires passing through the axial passage of said hollow motor shaft, thus transmitting the power and data to both the rotary wing assembly and the logic control unit;

a data communication unit consisting of a modem board and an RS-232 board, and being used for transmitting external input data to said logic control unit;

a display bulb covering the top of said rotary wing assembly, said logic control unit and said motor unit while forming a sealed space in the bulb, said display bulb allowing a user to observe characters and/or images displayed by the LEDs from the outside of the bulb; and

an external casing mounted to a lower end of said display bulb and encasing said motor unit, said SMPS and said data communication unit.

2. The apparatus for displaying characters and/or images as set forth in claim **1**, wherein said logic control unit includes:

a micro controller;

a backup memory for storing data necessary to the operation of said display apparatus, said backup memory being of a nonvolatile type;

a working memory for reading the data stored in said backup memory;

a data latch buffer for latching data from said working memory by a predetermined number of vertical dots;

a latch clock generator for supplying clock data to said data latch buffer in response to an input/output control signal from said micro controller;

an LED data driver for reading data from said data latch buffer in response to the clock data from said latch clock generator; and

an LED array for displaying data under control of said LED data driver.

3. The apparatus for displaying characters and/or images as set forth in claim **1** or **2**, wherein the balance between the rotary wing assembly and the logic control unit is accomplished by adjusting the weight of said balance weight.

4. The apparatus for displaying characters and/or images as set forth in claim **3**, wherein said balance weight is covered with a balance weight cover at its top and bottom, thus being prevented from undesirably coming into contact with said display bulb or from scratching the display bulb during an assembling process of the display apparatus.

5. The apparatus for displaying characters and/or images as set forth in claim **3**, wherein each of said LEDs is free from a flange radially projecting outward from a sidewall of an LED mold of each LED.

6. The apparatus for displaying characters and/or images as set forth in claim **5**, wherein each of said LEDs has one or more LED chips arrayed in one LED mold in a horizontal, vertical, diagonal, or triangular arrangement.

7. The apparatus for displaying characters and/or images as set forth in claim **3**, wherein said logic control unit is covered with a cover at its circular end portion to reduce noises and air resistance during a rotating action of said logic control unit.

8. The apparatus for displaying characters and/or images as set forth in claim **3**, where a secondary side of said SMPS is supposed to be turned on when a primary side thereof is turned off, and said SMPS includes:

an AC input unit;

a DC converter for converting an AC voltage from said AC input unit into a DC voltage;

a pulse width modulation (PWM) control/generation circuit for controlling the output of the DC voltage converted by said DC converter to generate a high voltage;

a high voltage/low voltage converter for converting the high voltage from said PWM control/generation circuit into a low voltage;

a smoothing circuit for smoothing the low voltage converted by said high voltage/low voltage converter; and

an output voltage detector for detecting a voltage signal from said smoothing circuit and transferring the detected voltage signal to said PWM control/generation circuit.

9. The apparatus for displaying characters and/or images as set forth in claim **4**, wherein said balance weight is a screw-type balance weight or a compression-type balance weight.

10. The apparatus for displaying characters and/or images as set forth in claim **1**, wherein said motor unit is an induction motor unit, with the stator and a motor casing of said motor unit being rotatable at the same time while accomplishing a rotational symmetry around the hollow motor shaft.

11. The apparatus for displaying characters and/or images as set forth in claim **1**, wherein an electric wire and a data communication wire from said secondary board of the SMPS pass through the passage of the motor shaft prior to being connected to said logic control unit.

12. The apparatus for displaying characters and/or images as set forth in claim **1**, wherein said secondary board of the SMPS is provided with a transparent optical sensor unit, said sensor unit being integrally formed with a light emitting part and a light receiving part for sensing both a rotating velocity of said rotor of the motor unit and an initial rotating point of the rotor.

13. The apparatus for displaying characters and/or images as set forth in claim **1**, wherein an optical transistor is mounted to a central position of a ferrite core, said optical transistor being used for optically receiving a variety of data transmitted through a power feedback signal IR (infra-red) of said secondary board of the SMPS or through a power feedback signal IR of said primary board of the SMPS.

14. The apparatus for displaying characters and/or images as set forth in claim **13**, wherein the various data are transmitted from cellular phones, pagers, FM tuners, digital radio systems, RS-232, modems, and keys.

15. The apparatus for displaying characters and/or images set forth in claim **1**, wherein said primary and/or secondary ferrite core forms the secondary side of the EE or EI core formed in the shape of a circle or square.

16. The apparatus for displaying characters and/or images set forth in claim **3**, wherein said primary and secondary-side bobbins of the SMPS are separated from each other, said secondary-side bobbin is situated inside primary-side bobbin while being upwardly spaced somewhat apart from the primary-side bobbin, and said primary-side bobbin is mounted to be fixed and said secondary-side bobbin is mounted to be rotated.

17. The apparatus for displaying characters and/or images set forth in claim **16**, wherein said primary and secondary-side bobbins of the SMPS are laterally spaced somewhat apart from each other, and the primary-side bobbin of the SMPS is mounted to be fixed and the secondary-side bobbin of the SMPS is mounted to be rotated.

18. The apparatus for displaying characters and/or images as set forth in claim **1**, wherein the modem board is connected to external communication means via stereo- or mono-phone jacks, said stereo- or mono-phone jacks being mounted on the inside-support bracket.

19. A method for displaying characters and/or images comprising the steps of:

a) applying power to a character and/or image display apparatus and setting up input/output port values and initialization values;

b) initializing all LED values and clearing a screen;

c) reading initial picture data from a nonvolatile backup memory;

d) writing the data read from said backup memory into a working memory;

e) reading initialization data from said working memory;

f) displaying an initial picture and performing a still mode until a rotation speed of a motor becomes stable;

g) reading data other than the initialization data from said working memory;

h) sequentially performing modes corresponding to commands contained in the read data; and

i) repeating said steps g) and h) until all commands stored in said working memory are processed.

20. The method for displaying characters and/or images as set forth in claim **19**, wherein said commands include a data reception command, a data storage command, a line back & forth command, a frame up command, a frame down command, a reset command and a complex command.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,380,686 B1
DATED : April 30, 2002
INVENTOR(S) : Jae Chul Kim et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7,
Line 1, "are a detailed diagram" should read -- are detailed diagrams --.
Line 6, "are a view" should read -- are views --.
Line 19, "are a view" should read -- are views --.
Line 33, "are a detailed flowchart" should read -- are detailed flowcharts --.

Column 12,
Line 24, after "(switch mode power supply)" delete period ".".

Signed and Sealed this

Twenty-fourth Day of September, 2002

Attest:

Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office